THE

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INTERIOR WIRING.

THE WIRING RULES OF THE INSTITUTION OF ELECTRICAL ENGINEERS.

THE rules just issued by the Institution may be taken to be as far in advance of those superseded as electrical science is now compared with its position at the time the Council first formulated wiring rules. Particularly would we expect this, as a printed circular was sent out in December last, stating that the Special Committee charged with the preparation of the new rules were anxious to recommend a system of testing which would be of universal application, and the replies from members of the profession all over the country must have given the results of a large amount of practical experience, and therefore been of the utmost value.

The old rules were subjected to keen criticism, and no one acquainted with the practical conditions of interior wiring work seemed to have very much to say in their favour. Indeed, it was seldom they were referred to: the Phœnix rules, so arduously kept up to date by Mr. Heaphy, apparently being regarded as standard, and these were cited in all important cases. It is now a case of "The King is dead, long live the King," and as the last comers attract most attention, we may leave the defunct rules alone, and confine our attention to those bearing date July, 1897.

The Council distinctly state that these are to be regarded only as general rules embodying the chief precautions and requirements necessary to secure satisfactory results in ordinary cases. Regarding them in this light, we should expect to find that in any case where they were strictly enforced the work would be done in such a way as to be free from risk of fire, of extinction or danger to the person. It is claimed that by complying with the requirements work can be carried out economically, both with regard to the first cost and after expense of maintenance. Although this is largely correct, there are several points on which opinion will differ, and in a number of instances it may be truly said that the Institution has been lax rather than unduly stringent.

Anyone who has had an intimate acquaintance for years with the wily wiring contractor of the species whose work is to be found connected to the supply mains in London and provincial towns is aware that this gentleman often either cannot or will not see the necessity of carrying out the work entrusted to him so that a reasonable man would admit it complied with any set of wiring rules held in good repute.

To be more precise, it is convenient to recall a few of the defects met with daily in one's peregrinations round wiring jobs. Frequent causes of complaint are:—

(*a*) Wires in contact at crossings for tees and branches.

(*b*) Wires quite unprotected at back of switchboards.

(*c*) Absence of casing or other protection in passing through walls, and between floor and ceiling, or behind wainscoting.

(*d*) Switches and fuses with back connections, live metal work touching wood, frame, or even brickwork.

(*e*) Joints (fearful and wonderful in character and insulation).

(*f*) Connections to fittings, effected as best suited the taste of the individual erecting same.

(*g*) Fuses on mains and branches so large that street fuse inevitably goes in case of trouble.

And yet we have already extant the Phœnix; the London, Liverpool, and Globe rules for general use; and those issued by the St. Pancras Vestry and the Manchester Corporation, as excellent examples to follow in particular cases.

Conductors.

Under this heading the new Institution rules depart from the time-honoured "thousand amperes per square inch density," and prescribe a strictly theoretical gradation based upon ratio of area to circumference. No doubt this is a more correct—or, as the mathematician would call it, elegant—method of arriving at the proper size of conductor to be used, but it lacks simplicity. The argument that large conductors are, by the old rule, necessarily overloaded, would be of importance if, firstly, the average job required the use of anything above the smaller sizes (do not companies and local authorities usually restrict the supply on one service to 50 amperes at 100 volts or 25 amperes at 200 volts?); or, secondly, if the new classification materially altered the loading on any particular sized conductor. Practically, however, the currents on the smallest sizes only are affected, and the change operates to *increase* their carrying capacity, which is only too likely—if acted upon—to introduce difficulties in the direction of excessive pressure drop in house wiring, and may bring contractors into collision with electricity supply engineers, who specify a maximum total drop between meter and farthest lamp for jobs connected to their street mains.

The size being determined by the heating of the conductor, a maximum temperature of 130° F. is specified, this allowing a rise of 30° F. above the highest air temperature. The sizes, with the currents allowed by old and new classifications of conductors most generally used are given below:—

Size S.W.G.	1,000 amps. sq. inch.	Inst. E.E. Average.	Inst. E.E. Maximum.	Insulation. Rubber.	Insulation. Compound.
18	1·9*	3·1	4·2	1,200	300
16	3·3*	4·9	6·8	„	„
14	5·4*	7·0	9·8	800	„
7/20	6·7†	9·3	13·0	600	„
7/18	14·2†	14·0	21·0	„	„
7/16	23·2†	23·0	34·0	„	„
19/18	35·8†	31·0	48·0	„	„
19/16	63·0†	49·0	77·0	„	„

* Glover's tables. † Crompton's tables.

It will be noted that for 7/18 and 7/16 the currents for hot positions are the same as under the 1,000 ampere square inch rule, while the maxima are all considerably higher. The wiring contractor is thus given considerable license, and he is liable to overlook the importance of drop, while fuses will be heavier and therefore less sensitive. On 200-volt work 20 lamps (8-C.P.) could be put on a single 18 S.W.G., a concession not likely to result in much satisfaction in the long run. Again, consumers are prone to change 8 C.P. to 16 C.P., and so on, and if the wires are already cut fine in section, overloading is sure to result. We can only hope that a liberal margin, at least 50 per cent., be left when installing.

Conductors are required to be of copper, of 100 per cent. conductivity, and *preferably* tinned. Tinning should be compulsory—not permissive—as joints are then more likely to be thoroughly made. The smallest conductor allowed is No. 18, and all above No. 14 must be stranded. It would have been better to require all above No. 16 to be stranded.

Insulation.

The rubber-age is evidently passing away, and compound insulation is now recognised officially for, perhaps, the first time as regards interior work.

Two classes are mentioned, and the respective qualities of dielectric require testing in different ways.

A Dielectric Impervious to Moisture, (*i.e.*, Rubber, &c.)	B Armoured or Sheathed Compound Insulation.
(*a*) Thickness to be = 30 mils + $\frac{\text{dia. of cond.}}{10}$	(*a*) Same.
(*b*) Not to soften below 170° F.	(*b*) Same.
(*c*) Insulation tested at 60° F., 60 sec. electrification after 24 hours in water.	(*c*) Same.
(1) To be braided, or taped and compounded.	(*d*) Test-piece to stand 2,500 volts (40-100 *f.*) for 10 m. in water, after bending 6 times to radius of 12 times dia. of dielectric.
(2) Laid in casing or conduit.	(1) Ends to be protected.

The most important alteration in this section is the high insulation resistance required for rubber dielectric. Very few engineers specify more than 600 Ω, and it is questionable if there is an advantage to be gained by going in for higher figures unless pure rubber joints are prohibited altogether, and either vulcanised jointing insisted upon, or complete distribution-board work made imperative. Some 200-volt rules ask for 2,500 Megohm wire. Surely a system of electric lighting requiring this cannot be suited to the needs of every-day existence?

The pressure or stressing test for compound insulation is of great value, and the figures do not seem to be at all out of the way.

Flexible Cord.

We now come to a debatable question, for "flex" as used every day is the great source of weakness in ordinary class work. In our opinion pure rubber flexible should never be used on first-class work, and certainly not on pressures above 110 volts. Neither should its use be sanctioned for the wiring of fittings. The rules as to this are, briefly, as follows:—

1. Only to be used for portable fittings or wiring of fittings.

2. "Any fitting containing many lights and wired with flexible cord should be supplied by conductors carried back to the distributing centre."

3. Flexible cord to be insulated with pure rubber in two laps breaking joint, or vulcanised rubber.

4. Thickness of dielectric to be 16 mils up to 125 volts.
„ „ 20 „ 250 „
(No distinction anywhere being made between continuous and alternating currents).

5. One yard sample to stand 1,000 volts (40-100 *f.*) for 5 m. between conductors, when placed 3 feet over boiling water (4 and 5 are both satisfactory precautions).

The only place where flexible cord can be regarded as being suitably disposed is when it is used for suspension fittings or pendants, and hangs in air from a ceiling rose, and is not in contact with or likely to touch earthed metal-work or any part or portion of a building or its fittings.

Joints.

Resin, although not mentioned, is evidently desired as a flux. It is not stated that joints must be vulcanised (on rubber cables), although that is the only way to "make the insulation of the joints as nearly as possible equal to the insulation of the remainder of the conductor." Joints can be avoided by "looping-in"—a method apparently known to only a few wiring firms—provided that the bore of fittings, and holes in fuses, &c., are large enough to admit two wires in each hole and four wires in a pipe or tube. No one who desires to do good work uses less than $\frac{3}{8}$th inch nipples, for this reason partly. In future rules we hope to find that "joints" are omitted altogether, and when that time comes, contractors will wire solely on the jointless distribution system—a system not likely ever to be beaten.

Arrangement.

1. Circuits restricted to 5 amperes (presumably up to 125 volts, and 3 amperes up to 250 volts).

2. Incombustible conduits with both conductors therein preferred. (No special mention is made of "insulated conduits," so we presume the gas pipe system, so much appreciated by Mr. Heaphy, is in view. Be it noted, hardly anything is said about wood casing, and yet 99 out of every 100 lamps fixed are on casing.)

3. Conductors to be mechanically protected.

4. (*a*) Conductors of *same* polarity may be bunched if taken from D.P. fuse.

(*b*) Conductors of opposite polarity may be bunched if in non-combustible conduit.

The Phœnix rules appear to recognise the latter, but not the former case.

5. Use porcelain tubes or conduits through walls.

6. Avoid gas-fittings, and combined gas and electric fittings, converted gas-fittings cut off from gas pipe by insulating union.

The above seem to be straightforward and desirable, but in the next condition we have added choking coils and enlarged the scope slightly by gathering from three parts the recommendations on this head.

7. Resistance (or choking) coils (or compensators) must be fixed on non-combustible (metal or slate) frames, with a ventilated metal case or cover, and be fixed by insulators off the wall, away from woodwork by 6 inches horizontally and 2 feet vertically, and must not rise above 212° F.

Switches, &c.

1. Ample carrying capacity. Not heat with 50 per cent. overload.

2. Break current without arc. Fly-off action. Stand 50 per cent. over-pressure.

3. Incombustible, insulating base and cover, or cover clear of live metal parts. (Common defect in "Tumblers.")

4. Insulated handle.

5. Front connections only should be insisted upon.

The summary of the rules relating to switches may so far be accepted without question, but we now come to a point about which no little discussion has taken place, as will be remembered by those who attended the Board of Trade Conference on "Regulations."

"Main switches should be placed . . . at the transformer, if transformed" (*i.e.*, the supply) "within the building, or at the point of entrance of the conductors into any building from an external source."

Query No. 1.—How can main switches be placed "at the transformer," unless they are inside the transformer case?

If so, they form a part of the distributing plant, and must be under "the sole control of the undertakers." (*Vide* Board of Trade regulations.)

Query No. 2.—How can main switches be placed at the "point of entrance" of the conductors, without putting them between the service and the meter?

If so, the undertakers must provide them (why?)—or the registration of the meter is endangered.

Query No. 3.—What is "the point of entrance," and how in actual practice can main switches be made to permit of their being fixed in that position?

Had the wording been "near the, &c.," the open questions would have required no asking; as it is, we leave them for the amusement of such of our readers as are fond of problems of an abstruse character.

Several of the minor details follow the run of other rules thus:—Fuses on opposite poles should either be separated, or be placed under separate covers. When branches are D.P. fused, ceiling rose fuses are unnecessary, and 3-ampere circuits are amply protected by D.P. fuses on distributing boards. "Fuse covers should be ventilated;" this is a thing most makers have yet to do. Partitioned fuses are not referred to, yet they are most suitable above 150 volts. Floor sockets are referred to, and conditions affecting them given: it would have been desirable to forbid them *in toto*. Standard fuses are recommended, and it is to be hoped that this will have some effect with wiring contractors for the usual result of a "short," be it but in a lamp-holder, is to blow the street fuse (which will carry, say, 15 amperes for any length of time, and requires 30 amperes to melt).

Machinery, &c.

1. All dynamos, motors and transformers, should be earthed (on frames).

2. Transformers, &c., "must be placed in a fire and waterproof structure."

A cast-iron tank is a "fire and waterproof structure," Presumably, therefore, it complies with this condition.

High tension cables leading into a transformer should always be run in a heavy cast-iron pipe, and transformers be fitted with an earthing device. Both these points are dealt with in the Board of Trade Regulations, and need not be included in house wiring rules.

We note that arc lamp globes are required to be netted. Most of those in use in London are not so treated, but it might be as well if they were. Again, all parts are to be insulated. This means that the frame of the lamp must not be included in the circuit—as is the case with most lamps. Makers ought to put this right, as trouble has been caused ere now by this very want of consideration for the suppliers of electricity, who ought, however, to look after their own interests, and refuse to connect jobs with only half insulated arcs.

Arc lamps to be double-pole switched and fused is as it ought to be, but they ought to be prohibited in places where explosive vapours are present, and no exception made where air cannot normally have access to the carbons.

The testing section is worthy of separate consideration, and will receive attention next week.

We have analysed and summarised the Institution rules in the manner set out above for the benefit of those interested in this question, to make it quite clear wherein modifications are attempted. In our opinion, all that is asked for is asked in reason, except, perhaps, the raising of the insulation of conductors. On the other hand, the current density has been so much raised, and the insulation-to-earth test lowered to such a degree, that we feel the Institution would have acted more wisely in keeping up the standard as set to-day by other reputable rules, and not lightly giving forth conditions which in several particulars clash with the Supply Company and other regulations at present in force.

POWER HOUSES OF THE BROOKLYN HEIGHTS RAILROAD COMPANY.

By HERBERT GUNTON and HAROLD LOMAS.

The city of Brooklyn is situated on Long Island, just opposite New York, to which it is connected by the Brooklyn Suspension Bridge. The population is estimated at about one million, and the area covered is about 70 square miles. The enormous traffic throughout the city is dealt with by elevated railroads and street railways; the latter being practically all operated by the electric overhead trolley system.

The Brooklyn Heights Company operates about 183 miles within and 50 miles outside the city limits, and leases the track from the Brooklyn City Railroad Company. The overhead electric system was adopted in 1894, and it appears that the cost of conversion from horse to electric traction was about £3,000 per mile of single track.

The manner in which the overhead construction is carried out is not pleasing to the eye, and certainly would not be tolerated on this side of the water. Where the lines run beneath the elevated railroads the trolley wire is suspended by means of span wires fixed to the side columns of the elevated railroad, the feeders, which are centrally between the two tracks, being carried on beams fixed to the cross girders.

In the case of the open streets, the trolley wire and also the guard wires, which are used as telephone wires between the stations, are suspended from span wires between poles at either side of the streets, the poles also carrying the feeders.

Power is supplied from three stations, the eastern, the southern, and the Ridgewood, situated at different points in the district.

The southern station contains six 1,000-H.P. cross compound condensing Corliss engines by the E. P. Allis Company, each engine driving, by means of belt, two 500-k.w. General Electric generators, which are situated on the floor above the engine room. The two machines, driven by one engine, are capable of being separated by means of a clutch.

The Ridgewood station contains three 700-H.P. tandem compound non-condensing engines by McIntosh & Seymour, each engine driving, by means of belt, two 300-k.w. General Electric generators, situated on the same floor, and having the same arrangement as in the southern station for disconnecting the two machines.

The eastern station, which will be described in detail later, contains four 2,000-H.P. cross-compound condensing engines by the E. P. Allis Company, each engine driving direct a 1,500-k.w. General Electric generator.

It will be seen that three different types are represented by these stations, and it will be interesting to refer to the following figures, which give the average cost of the three power stations for the year 1896:—

Southern Station.

	Cost per kw. hour.
Operation supplies	$ ·003507
Operation labour...	·002815
Supplies repairs	·000235
Labour repairs	·000370
Total average cost per kw. hour ...	$ ·006928

Ridgewood Station.

	Cost per kw. hour.
Operation supplies	$ ·005702
Operation labour	·003393
Supplies repairs	·000197
Supplies labour	·000295
Total average cost per kw. hour ...	$ ·009589

(N.B.—This station is shut down two or three hours every night.)

Eastern Station.

	Cost per kw. hour.
Operation supplies	$ ·002958
Operation labour	·001896
Supplies repairs...	·000179
Supplies labour	·000256
Total average cost per kw. hour ...	$ ·005291

As the economy of the system so largely depends on the ratio $\frac{\text{average load}}{\text{maximum load}}$, it is usual to work the three stations in conjunction, this being effected by telephonic communication. By judicious use of the smaller units in the Southern and Ridgewood stations, the large and economical units in the Eastern station can be kept fully loaded, thus obtaining the economy of a storage battery equipment without the accompanying disadvantages. The following is a specimen of the daily report of the three stations:—

Brooklyn Heights Railroad Company.
Daily Report of Power Station.
Saturday, *February* 13*th*, 1897.

	Eastern.	Southern.	Ridgewood.	Totals.
Maximum load, amperes ...	13,600	7,500	3,300	...
Engines run...	4	5	3	...
Average load, amperes ...	7,531·3	4,292	2,078·7	13,902
Total output, kilowatt ...	103,282·4	58,774·8	27,636·5	189,693·7
Coal burned, pounds ...	287,200	196,789	148,967	632,956
Coal per kilowatt-hour ...	2·787	3·35	5·49	...
Water used, cubic foot ...	32,400	9,680	12,950	55,030

With coal at $1·75 per ton, the cost of coal per kilowatt-hour is $·002217.

The total mileage run by the cars for the month of January, 1897, was about 2,000,000.

Repair Shed.

An extensive repair shed is provided at the southern end of the system, and here the cars have their equipments altered and renewed. It is usual to equip the closed cars which are run throughout the winter with two motors, one of these being taken out and fitted to an open car at the commencement of the summer season. The single motor equipment generally consists of a 30 H.P. Thomson-Houston motor worked by a rheostatic controller. In the case of a car worked continually with two motors, the usual equipment consists of two G. E. 800 motors of about 25 H.P. each with the series-parallel controller.

The repair shed includes a large armature and magnet-winding shop, and here several of the best known armatures are to be seen, such as the General Electric, Curtis, Westinghouse, and Thomson-Houston.

The Eastern Power House.

This station is conveniently situated on the East River, from which the condensing water is drawn, and coal is supplied by barges. Buckwheat anthracite coal is used, and this is hoisted by an elevator and conveyor into a pocket having a capacity of about 6,000 tons, from which it is weighed and fed down into the boiler room.

The steam raising plant consists of 24 double drum Babcock-Wilcox boilers of 250 H.P. each, arranged in pairs, eight batteries being situated on the ground floor, and four on the floor above, with the main flue between the two tiers. The boiler feed, for which city water is used, is supplied to the boilers by two Worthington compound duplex feed pumps, each capable of delivering 675 gallons per minute against a pressure of 160 lbs. The feed can be supplied direct to the boilers or through four Green economisers, which are so arranged that the feed passes through them, either two in series or in multiple. With all four economisers in multiple, the feed can be heated from 44° to 160° in winter, or 68° to 180° in summer, while with two economisers in series, it can be heated from 44° to 170° in winter, or 68° to 190° in summer. All steam and feed mains are in duplicate. The feed mains are formed of 8-inch drawn brass tube, and the steam main is 20 inches in diameter, of lap-welded steel, fed by 8-inch branches from the boilers, and having 10-inch branches down to the engines. When working non-condensing, the exhaust to the atmosphere is by means of a 36-inch cast-iron main. The engine room is spacious and well lit, and measures 169 feet × 122 feet.

The plant consists of four direct driven sets, each consisting of a 2,000 H.P. cross compound condensing horizontal Corliss engine by the E. P. Allis Company, and a 1,500 kilowatt General Electric generator, the fly-wheel and generator being placed between the high and low pressure engines. The cylinders are 32 inches and 60 inches diameter by 5 feet stroke, and are jacketed with steam from the boilers reduced down to 20 lbs. pressure. The governor controls both the high and the low pressure cylinder. The

fly-wheel is built up in 10 sections, and is 25 feet in diameter, the rim and spokes weighing about 65 tons. The lubrication is forced, and the babbited bearings require very little attention. The type of condenser used with these engines is the Wheeler surface condenser, the air and circulating pumps being supplied by the E. P. Allis Company.

The generators are the General Electric Company's Type M.P.—Class 12—1,500—75. They give about 2,500 amperes at 570 volts when running at 75 revolutions per minute. They have 12 poles, are compound wound, and are fitted with carbon brushes.

There is room in the engine room for two more of these sets. The two bays into which the engine room is divided are each served by a 65 ton travelling crane.

The switchboard is mounted on a gallery at one end of the engine room, and is fitted with the usual instruments. The mains from each generator are brought up through a D.P. switch at the bottom of the board. Above this is the field regulating switch, and also a two-way switch for exciting the field from the bus bars on starting up.

Above this is a Weston ammeter, and, lastly, at the top of the panel is the compound wound circuit breaker. The centre panel of the generator board contains a switch for resetting the circuit breakers.

The feeders, of which there are about 40, are fed through S.P. switches and Weston ammeters, arranged at the front of the platform and apart from the generator board. The pressure is measured by a Weston voltmeter, which can be plugged on to any machine or bus bar.

Electrolysis due to Earth Return at Brooklyn.

The trouble encountered in Brooklyn owing to the corrosion of gas and water pipes by the earth return currents to the power houses has been dealt with in the Electrical Review of January 22nd, 1897.

The engineers of the Brooklyn Heights Railroad Company are doing their best to improve matters. Last year a large quantity of the light rails were replaced by 94-lb. rails, and this year 100-lb. rails are being used. Particular attention is being paid to the bonding, brazed bonds 4 inches long and of 400,000 circular mils section being used, by means of which it is estimated that the total conductivity of the track, including the bonded joints, will be about 90 to 95 per cent. of the conductivity of the iron itself.

The engineer of the Brooklyn Heights Railroad Company is Mr. Whittlesay, who gave us his willing help in gathering the above information.

220-VOLT LAMPS.*

By G. D. SHEPARDSON.

As much of the pioneer work in the adoption and development of the 220-volt system has been done in the Northwest, it is fitting that the first public report of accurate commercial tests of lamps should be made before the Northwestern Electrical Association.

Many difficulties were encountered at first, but these have been overcome to a large extent. The business has increased to such a degree that the 220-volt lamp seems to be in the field to stay. Reports from the plants are almost invariably encouraging, whether coming from manager or from patrons. The advantages of using higher voltages are well understood by engineers. The 220-volt lamp has been so successful for lighting villages and small cities that the alternating system seems to have given way, and almost all of the new plants in such places now adopt the 220-volt direct-current system, where a few years ago alternating systems had the field almost to themselves. The companies using the three-wire systems also find in the 220-volt lamp the possibility of extending their lines to outlying districts, and of operating motors at 440 volts directly from the outside mains of the lighting service, instead of requiring special 500-volt generators and power circuits.

It is urged against the 220-volt lamp that it is of lower efficiency than the 110-volt lamp, so that the power plant must be larger to supply an equal amount of light. The larger item of interest on first cost of power plant and larger fuel account may more than offset the saving in cost of copper, if calculated for the same percentage loss. The 220-volt lamps also cost more than the 110-volt, but this is unimportant, since the first cost of an incandescent lamp is only a small fraction of the value of the current used during its lifetime. Again, the average life of the low efficiency 220-volt lamp seems to be longer than that of the higher efficiency 110-volt lamp, so that the cost of renewals may even be in favour of the 220-volt lamp.

The economy of copper is even greater than indicated by the foregoing discussion. The allowable drop on a system of distribution is not determined in practice by Kelvin's much-quoted and imperfectly understood law that the greatest net economy is secured when the value of the watt-hours annually lost on the lines just equals the interest and depreciation on the part of the line whose cost is directly proportional to the weight of conductor. The loss is usually determined in practice by the maximum variation of candle-power that the customer will tolerate. Changes in the distribution of the load must be provided for, and the system must be so planned as to avoid excessive variations of voltage. The high voltage on some lines that are lightly loaded when others have heavy loads gives fine light for a time, but the lamps age rapidly and give poor service. This, of course, is well understood by station managers, who wisely furnish low-efficiency lamps for such places. The 220-volt lamp cannot be made with as high efficiency combined with reasonable life as can the 110-volt lamp of equal candle-power, on account of the smaller diameter and greater length of the filament. When operating at high efficiency, the temperature of the filament is higher and the filament is therefore softer, less rigid, and mechanically weaker. Since the 110-volt lamp is operated at as high a temperature as is practicable, it is seen that the 220-volt lamp, with its longer, smaller, and much weaker filament, must continue to be less efficient. Whatever improvements may raise the practical efficiency of the one will also improve the other, so that their relative efficiencies must remain about the same, unless the 110-volt lamp meets the fate of the 52-volt and becomes a back number.

The necessarily low efficiency of the higher voltage lamp is not an unmixed evil. For since its efficiency is low, the allowable variation of voltage is greatly increased. Consequently, if two systems, one for 110 volts and one for 220, be laid out for equal percentage variation of voltage, the variation of the light from the 220-volt lamps will be hardly noticeable when that of the higher efficiency 110-volt lamp will be intolerable. From this it follows further that if the two systems be laid out for equal fluctuation of light, the 220-volt system will allow much greater percentage range of voltage and require correspondingly less investment in copper. This seems a reasonable result, even allowing for the counterbalancing greater drop due to the lower efficiency of the 220-volt lamps. The conclusion is therefore reached that the 220-volt system requires considerably less than one-fourth the weight of copper required by the 110-volt system for serving the same district with equal satisfaction to users. When it is considered that the cost of the feeders and main often equals or exceeds the entire cost of the station equipment, it appears that the great saving in copper easily balances the increased cost of the larger generating plant and of the larger amount of fuel.

While the writer has not calculated in detail the exact results for any particular case, it is believed that the above argument is in the right direction, and it is hoped that others in possession of more extended data may work out the problem in its commercial aspect.

Although 220-volt lamps have been on the American market for several years, there is a lack of published information regarding their performance. It is generally known that the lamps cost more and require more watts per candle than the 110-volt lamps, but exact figures are hard to find. In order to obtain accurate and reliable data concerning various 220-volt lamps on the market, new lamps were secured from the regular stock of several lighting plants in Minnesota, representing the regular output of three different manufacturers as furnished to regular customers. Samples were obtained directly from another manufacturer for test purposes. Lamps were ordered from a fifth factory,

* Extracts from a paper read at the meeting of the North-western Electrical Association, La Crosse, Wis., July 21-22, 1897.

which claimed extraordinary results, but they declined to furnish the lamps ostensibly on the plea of being behind their orders owing to an unusual rush of business.

Arrangements were made for a life and efficiency test of the various lamps. Before and after the life test two lamps of each make were tested for efficiency, by varying the voltage through a considerable range, and measuring the candle-power at various voltages.

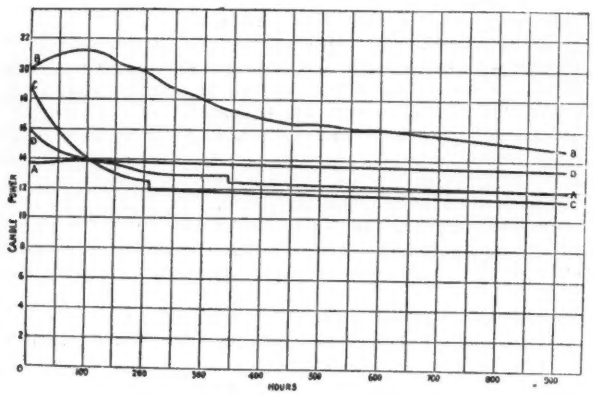


Fig. 1.

All of the lamps were operated continuously at the voltage marked upon their bases at the factory. For one lot of lamps marked 220 volts the line voltage was raised by three storage cells, which were renewed daily and kept well charged. Five lamps of each make were tested, three being placed vertically and two horizontally. Of the two horizontal lamps, one had the shank or stem in a horizontal plane, the other in a vertical plane. Readings of candle-power and current at the marked voltage were taken each night for each lamp, the results being given in the accompanying curves (fig. 1). The various makes of lamps are marked A, B, C and D.

The curves showing the variation of watts per candle (fig. 2) with the life show equally interesting results.

At the end of 921 hours the life tests were stopped, but since nearly all the curves of candle-power and of watts per candle had become practically straight lines, it would probably be safe to exterpolate and prolong the curves almost indefinitely in the directions indicated.

The record of breakage is somewhat interesting. Twelve

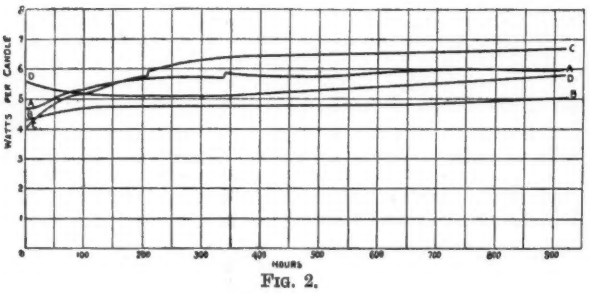


Fig. 2.

lamps of the make marked D were obtained from the factory, six directly and six through an agent. Four broke in transit, two exploded as soon as connected into circuit. Of the two placed with globes horizontally, the one having the plane of the filament at base in the vertical position lasted throughout the life test, while with the one with plane of filament in the horizontal position the filament drooped in 159 hours so far as to touch the globe and crack it. The filament of the corresponding lamp of group C drooped and broke the globe in 215 hours. The corresponding lamp of group D broke in the same way in 315 hours. The anchor in the horizontal lamp of group A, having the plane of shank vertical, broke and allowed the filament to touch and break the globe after 345 hours. With these exceptions all the lamps were in fair condition at the end of 920 hours when the test closed. The conclusions seem to be that if the lamp is hung vertically it will last 1,000 hours or more if it lasts 10 minutes. If the lamp must be placed horizontally, the shank of the filament should be vertical rather than horizontal. It is also suggested that the size of globes might be increased with advantage.

As a matter of general interest a new lamp of each group was subjected to a breaking test. Each lamp was placed in series with a water rheostat, and then connected across a 500-volt circuit. The rheostat was adjusted so as to bring the lamp to its normal voltage. The voltage was then raised slowly and at a nearly uniform rate until the lamp broke, the current and voltage at instant of breaking being recorded by one observer, while another noted the time taken to raise the voltage from normal to breaking point. The following table shows great variety, both in the toughness of the filaments and also in the change of resistance:—

Lamp.	Voltage.	Amperes.	Seconds.
A	316	1·06	31
B	366	·78	30
C	447	·85	40
D	378	1·10	31

The lamp tests here presented are offered not as an exhaustive research, covering all suggested or possible problems connected with the performance of high-voltage incandescent lamps, but simply as a modest contribution to the literature of a subject upon which much has been written but concerning which very little definite information is available. The tests were limited both in the number of lamps tested and in the length of the run, but they were made under commercial conditions, and it is hoped will be of some value to engineers.

A WIDE RANGE POTENTIOMETER.

By L. H. FRY.

This potentiometer devised specially for the calibration of voltmeters, but which is also adapted for all current and resistance measurements was designed by Herr Thiermann of the Hanover Polytechnikum.

It combines simplicity of conception and construction with a very wide range and a high degree of accuracy. By its means direct instantaneous measurements may be made of voltages ranging between 200 volts and 0·0002 volts, with an error of less than $\frac{1}{2}$ per cent.

The principle on which the instrument is constructed is as follows :—A galvanometer is joined in series with a large resistance and the E.M.F. to be measured. If the voltage is high a shunt of small resistance is placed across the galvanometer terminals. For lower voltages the resistance of the shunt is increased, and finally the shunt is removed. For still smaller voltages the original resistance has a smaller resistance placed parallel to it, which is decreased as the voltage to be measured decreases.

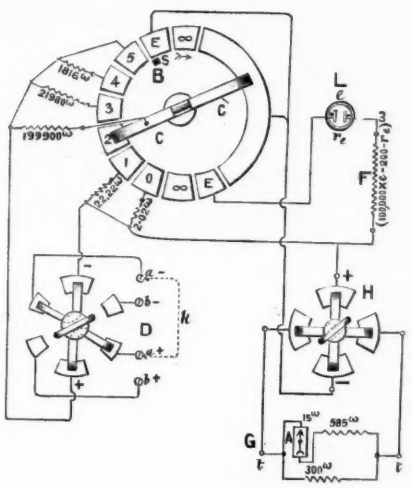
The fig. is a diagram of the whole instrument with its connections. B is a circle of contacts connected to five resistances and swept by the revolving arm, C. L is an element of accurately known E.M.F. which is used in conjunction with the resistance, F, for the adjustment of the instrument. D is a "selector" allowing either terminals $a+$ and $a-$, or $b+$ and $b-$, to be included in the galvanometer circuit. G is the galvanometer with its resistances, and H is the galvanometer commutator.

The Galvanometer, A, was constructed by Siemens and Halske of Berlin, and is a reflecting instrument of the Deprez type, with a suspended coil, and with a scale divided in millimetres. To render it independent of temperature changes, it is constructed as follows :—The suspended coil is of copper, and has a resistance of 15 ohms ; in series with this coil is an auxiliary resistance of 585 ohms made of a constant resistance alloy. If we assume a change of temperature of 10° C. and a temperature coefficient of ·0038 for the copper, we then have a change of resistance of ·0038 × 15 × 10 = ·57 ohms; this, in 600 ohms galvanometer resistance, is less than $\frac{1}{10}$th per cent.

The suspended coil could not be made of any of the constant resistance alloys because they are all more or less magnetic.

The shunt of 300 ohms makes the damping of the galvanometer practically independent of the resistance of the external circuit.

The resistance of the galvanometer between the terminals, *t*, *t*, is 200 ohms.



To give a steady deflection the suspended coil is wound on a split copper frame, the circuit at the split being completed by a plug.

The induced currents in this frame (when the plug is in the split) brings the coil to rest at the proper deflection.

If it is desired to use the galvanometer ballistically the plug is removed.

Method of Using Instrument.

To Adjust.—The element, L, whose E.M.F. is accurately known, is connected up with the resistance coil, F, which has a resistance of $(100{,}000 \times e - 200 - \gamma_e)$ ohms, e being E.M.F. of the element in volts and γ_e the resistance of the cell in ohms.

The arm, C, is then turned on to the contacts, E, E. We then have the element, L, the resistance, F, and the galvanometer, G, all connected in series. The resistance of this circuit is obviously $100{,}000 \times e$ ohms.

If now

c = current.
e = the E.M.F. of the element.
κ = the galvanometer constant,
and a = the deflection due to current i.

From Ohm's law

$$e = c \times 100{,}000 \times e.$$
$$\text{but } c = \kappa a.$$
$$\therefore e = 100{,}000 \times e \times \kappa \times a.$$
$$\therefore c = 100{,}000 \times \kappa \times a.$$
$$\therefore \kappa a = 10^{-5}.$$

Now in order to be able to read directly in volts we must have $c = 5 \times 10^{-8}$.

Hence in present case we must have

$$a = \frac{10^{-5}}{\kappa} = \frac{10^{8}}{5 \times 10^{5}} = 200.$$

We bring the deflection to this value by shifting the telescope and scale. To allow of a final fine adjustment, the stand is provided with a micrometer screw, which moves the telescope and scale backwards and forwards in the line of sight.

Let us now see what happens if the arm, *c*, be turned off the contacts, E, E, pass the ∞ contacts on to the other six contacts in succession. A stop, S, is arranged so that we can only turn the arm off the contacts, E, E, in the direction indicated by the arrow. This prevents our injuring the galvanometer by inadvertently connecting a high E.M.F. with the contacts for measuring small potential differences. An examination of the fig. will show that six combinations of resistances may be obtained.

With arm on contact 0 we have a combination of resistances between points *p*, *p*, such that the scale reading in millimetres gives us the difference of potential in volts. We can with ease and accuracy read deflections between 200 and 20 mm., so that using the contact, 0, we can measure potential differences ranging from 200 to 20 volts.

Turning the arm on to contact 1, we have a combination of resistances such that we obtain the potential difference to be measured, in volts, by dividing the number of millimetres in the deflection by 10. Hence, with the arm on this contact we can measure from 20 volts to 2 volts. The next step brings the arm on to contact 2. Here we have the galvanometer directly in series with the resistance of 199,900 ohms, and, in this case, the voltage is obtained by dividing the millimetres of deflection by 100.

In this position we can measure from 2 to 0·02 volts. Bringing the arm on to contact 3 we have a combination of resistances such that the volts of P.D. between $a+$ and $a-$ are given by dividing millimetres of reading by 1,000, and we can hence measure voltages between 0·2 and 0·02 volts.

With the arm on contact 4 the voltage is given by dividing the millimetres of deflection by 10,000, and the range is from 0·02 to 0·002 volts.

Finally by bringing the arm on to contact 5, to obtain the voltage we divide the millimetres of the deflection by 100,000. We are here in a position to measure voltages between 0·002 and 0·0002 volts with the required accuracy.

The following is a summary of the combinations:—

Contact.	Resistance of whole circuit in ohms.	Proportion of current passing through the galvanometer.	Constant by which the m/m of the reading must be multiplied by to give voltage.
0	200,000	0·01	1
1	200,000	0·1	0·1
2	200,000	1	0 01
3	20,000	1	0·001
4	2,000	1	0 0001
5	200	1	0·00001

The number on the contact gives the number of decimal places we have to introduce into the reading in millimetres to obtain the P.D. in volts.

For current measurements we require an auxiliary resistance. If we choose 0·01 ohms we have only to multiply the voltage measured at the ends of this resistance by 100 to obtain the current in amperes.

To measure resistances we join the unknown resistance, x, in series with a known resistance, r, and a battery, and measure voltages at ends of each. If k_x be P.D. between $a+$ and $a-$, and k_r be P.D. between $b+$ and $b-$, we have

$$\frac{x}{r} = \frac{k_x}{k_r}$$
$$\therefore x = r\frac{k_x}{k_r}.$$

If the resistance is large, *i.e.*, of the same order as the galvanometer resistance or larger, then we measure the voltage by placing the selector on $a+$ and $a-$ and then moving the selector on to $b+$ and $b-$.

Suppose the voltage to be k. If the galvanometer resistance be g, and current in second case be c, we have

$$k = c\,g,$$

And considering the whole circuit

$$e = c\,(g + x)$$
$$\therefore \frac{e}{k} = \frac{g + x}{g} \qquad (A)$$
$$\therefore x = \frac{g\,(e - k)}{k}$$

Or if x is so large that we may neglect g in comparison to it we may write the equation (A)

$$\frac{e}{k} = \frac{x}{g}$$
$$\therefore x = g\frac{e}{k}$$

(g is the resistance given in the second column of the table).

We can measure very high resistances such as the insulation resistance of cables, &c., in this manner.

THE METERS OF TO-DAY.*

By R. F. SCHUCHARDT.

A good meter is always superior to the best contract. For the station manager the meter will give a good basis from which to estimate the schedule price, instead of making his guess at it; the ratio of income to cost of operation will be more fixed, and there will be less unnecessary burning, thereby increasing considerably the life of the lamps.

There are three classes of meters—electrolytic, clock, and motor meters. In the first, the quantity of current is measured by the amount of metal deposited or the quantity of electrolyte decomposed in an electrolytic cell. The only one of this class which has found much use in America is the Edison chemical meter, which though exceedingly accurate under proper conditions, has the decided disadvantage of having no recording device, and like all electrolytic meters is likely to freeze unless heat is provided, thereby entailing a loss.

The majority of the clock meters consist of two clocks, one of which keeps accurate time, the other being retarded or accelerated by the action of the current on its pendulum. The objection to this type is that the clocks must be wound up every month or so, and, if neglected, the meter will run backward and destroy all former readings. Of this class the Aron is the most successful, being constructed for both direct and alternating currents.

The most important class comprises those meters which operate on the principle of the electric motor. The American meters of this class are the Thomson, of the General Electric Company; the Duncan, of the Fort Wayne Corporation; the Shallenberger, of the Westinghouse Company; and the Scheeffer, of the Diamond Electric Company. The Thomson is built to operate on both direct and alternating currents, and consists of a simple motor with no iron in the armature or the field. All of the others are induction motors.

Mr. George H. Jones, of Fond du Lac, and myself, have just completed a thesis on American electricity meters under Prof. D. C. Jackson, at the University of Wisconsin, and I have drawn largely from our thesis for this paper. The results obtained in our investigations show that the meters of the present day are not all that might be desired. It is of the utmost importance that central station men test each meter they install. Many managers are beginning to realise the importance of this subject, and have added meter testing departments to their stations, where all meters are tested before they are installed. After they are once installed, they should be inspected every six months or so, in order to see that they are working properly. This is hardly ever done at present.

I have with me a few curves, showing the accuracy of some of the meters tested by us, which illustrate very clearly the action of these meters. Our method of calculating the error of the meter was as follows: The speed of the meter is directly proportional to the load, therefore, for a given load the product of seconds per revolution of the armature and amperes, in ampere-hour meters), or watts (for watt-hour meters), equals a constant (which we will call K) which varies with the make and size of the meter. As will be seen, K is the time in seconds which it takes for the armature to make one complete revolution per unit of load (ampere or watt.)

The product of the observed load and seconds per revolution divided by this K, $\frac{\text{amp} \times \text{sec.}}{K}$ or $\frac{\text{watts} \times \text{sec.}}{K}$ should then equal unity for an accurate meter, and the variation from unity will give directly the error. Should this quotient be more than unity, the meter runs too slowly on that load; and if less than unity, the error will be negative, which means that the meter is running too fast. Thus, let the time per revolution be four seconds for a load of 440 watts on a 10-ampere, 100-volt Thomson wattmeter. The value of it for this meter is 1,800; then $\frac{4 \times 440}{1800} = 978$, which shows that the meter runs 2·2 per cent. too fast on that load; or, let the time of the revolution of the armature be two seconds for 3·3 amperes on a 20-ampere Shallenberger ampere-hour meter in which the value of K is 6·33; then $\frac{2 \times 3{\cdot}3}{6{\cdot}33} = 1{,}042$. The meter is therefore 4·2 per cent slow on that load.

We found our samples of the Duncan watt-hour meters to run too fast, but by properly adjusting the magnets, their error could be brought within the limits of about 5 per cent. either side. Both of the Duncan ampere-hour meters tested started much too slowly, and were also much too slow on the high loads. The effect of frequency is very marked, the difference in error at full load between frequencies of 60 and 130 being about 30 per cent.

These Scheeffer wattmeters are designed for frequencies, and when built for two frequencies are provided with a special German silver resistance in the pressure circuit to compensate for the difference. One of the meters tested by us, built for frequencies of 60 and 130, ran with an average difference of about 6 per cent. between these frequencies.

Of the Thomson wattmeters, which are independent of frequencies, the new type started on no load, while the old ones started much too slowly. Their curve of error is a remarkably straight line after starting load.

The Shallenberger ampere-hour meters also started much too slowly. One of the three tested ran fairly uniform after starting, while the other two were too slow on high loads. The higher frequency makes them run from 5 to 15 per cent. faster. The Shallenberger watt-hour meter was found to be very fair. It started on a very light load, ran without any great error, and responded promptly to changes of load. Frequency has no appreciable effect upon it.

All of the meters tested are practically unaffected by the changes of pressure likely to occur in service. The Diamond wattmeter should not be used with inductive load, as the effect of such load is very marked, making the meter run much too slowly, and with a power factor low enough it stops entirely, and even runs backward.

Besides these meters tested in the laboratory, we were enabled, through the courtesy of the Madison Gas and Electric Company, to test meters in actual service. The general results of this test indicated that the ampere-hour meters require a comparatively large current to start them, run much too slowly on starting load and on the higher loads, while the majority of them have considerable error on overloads. The wattmeters are somewhat better, and, as a rule, run too fast on all loads, except at starting, and with a fairly uniform error. The Thomson meters show the least variation in error, but the continuous watts absorbed are more than in any of the others. A fact of great importance brought out in this test is the lack of proper attention paid to the installation of meters.

In choosing a meter, the following points should be considered:

It should be accurate within at least 5 per cent., either way, on all loads for which it is designed, and should begin to register on at most 1 per cent. of its full load. The power absorbed should not exceed 2 watts per 10 amperes capacity of wattmeter, nor should the full load drop through the meter be larger than ·5 volt. The reading should be direct and not have to be multiplied by a constant. The multiplier means extra work for the clerk, and offers a chance for an error, both in the calculation and in the possible omission. There should be no electrical contact makers, which rapidly deteriorate. Delicate mechanism should be avoided. The meter should not be liable to wear out, nor get out of order rapidly. The cover should be dust-proof and capable of being easily sealed. Last, but not least, comes the cost of meters: This is not only the amount paid for the meter, but includes the cost of energy continuously absorbed. In the case of a meter costing $10 and absorbing 10 watts continuously, with interest at 6 per cent., energy at 4 cents per kilowatt hour, and 10 per cent. for depreciation (which probably is a low value for a cheap meter), the annual cost

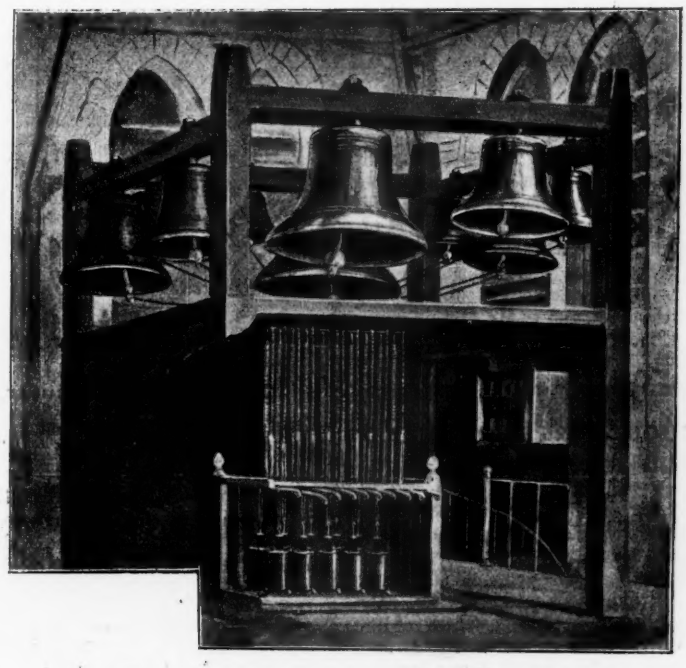
* Abstract of paper read at the La Crosse meeting of the North-Western Electrical Association, July 22nd, 1897.

of the meter to the central station is $5.10. A meter absorbing 2 watts at the same rates as above would cost $3 per year. At the end of 10 years the first meter will have cost $61, while the $20 meter will have cost but $59, and it ought still to be in good condition at that time. The higher priced meter is likely to be the more accurate. There are several ways in which a meter can be tested. In some methods the load is computed from the time per revolution of the armature, and the true load found on an indicating instrument. We think that a "per cent. error" states the condition more clearly than any method which finds the error in amperes or watts for the different loads. We also think our stop-watch method the most satisfactory, since it takes much less time, and therefore less power than the five-hour full load test used in some methods. For a satisfactory test, the starting load should be found, and also the time per revolution taken with a stop-watch, the accuracy of which can be relied upon, at starting, 1-4, 1-2, 3-4, 4-4 and 11-4 loads. Any number of ammeters can be connected in series and tested at the same time.

ELECTRIC TOWER CLOCK AND CHIMES, GRACE CHAPEL, NEW YORK.*

One of the recent instances of the almost infinite utility of the electric current is to be found far up in the tower of Grace Chapel, New York, where electricity has replaced the weights of the tower clock, and not only turns its wheels, but also strikes the quarters and the hours, and plays a curfew hymn at the close of the day.

And here it may be mentioned in passing, that the Grace Church Settlement, as it is called, with its chapel, its hospital for aged women and children, its club houses and gymnasium, its parish house and clergy house, and its fine assembly room, is one of the most complete religious and philanthropic institutions of its kind. Generous wealth combined with good architecture and engineering have produced an establishment which, from the engine and boiler room in the basement to the electrical clock and chimes in the tower (the latter a gift from the Misses Potter, of Sing Sing, New York), is replete with the latest mechanical and architectural conveniences of the day.



The Belfry Chimes Showing Magnets and Attachments to Clappers.

As our readers are well aware, the usual method of running tower clocks is by means of dead weight, the weights being wound up at stated intervals. The improvement in the Grace Chapel clock consists in the replacing of the weights by a small electric motor, thus obviating the necessity of electrical contacts and the mechanical disadvantage of starting and stopping heavy hands, as in the ordinary secondary system of operating clocks. The clock proper, which, with the keyboard, is located in a small room in the tower, is of the ordinary tower clock pattern, and differs from this only in the fact that the barrel on which the weights would ordinarily be wound is empty. The novel feature is a tiny electric motor which is carried upon an extension of the base upon which the "works" are placed. The current is furnished from a storage battery which is charged by the Grace Chapel dynamo, and has sufficient capacity to run the clock for two weeks in case it should be necessary to shut down the dynamo. In clocks of this kind, where an independent plant is not available, current could be taken from the city mains.

The motor shaft carries a small grooved pulley from which a coiled wire belt runs to a friction pulley on the arbor or shaft of the escapement gear, which is thus subjected to a steady pull, answering to the pull of the weights in an ordinary clock. Every movement of the escapement allows the shaft to rotate the required amount, and the resulting movements of the clock are transmitted by light hollow shafting to the tower clock dials. A cam on the minute shaft makes an electrical contact once a minute, and sends a current to a contact disc on the hour shaft. The disc is furnished with four contact points, which operate every quarter of an hour, to throw in a magnetic clutch and start the "Westminster Chimes" barrel, which will be noticed in the lower right hand corner of the clock. This barrel is similar to those which are used in a music box, being furnished with a number of pins which operate similarly to those of a music box cylinder. They do not strike the teeth of a comb, however, but serve to lift a series of small electric keys and pass successive currents through a series of wires which lead up to the chimes in the belfry.

Beneath the 10 bells are placed 10 powerful solenoid magnets, one to each bell. Each of these consists of an iron armature, which hangs, when the magnet is not charged, just within and above the solenoid coil. When the pins of the rotating barrel below strike a key, a current is passed through the solenoid coil in the tower and the armature is pulled violently down within the coil. The chain by which the armature is hung runs up over a pulley and attaches to the clapper of the bell, which is thus caused to make one stroke for every contact.

A similar mechanism to that above described serves to throw in a wooden cylinder, or barrel, at 9 o'clock every evening, which plays what is known as the curfew hymn; and after the hymn is played the clock remains silent through the night, in order that the neighbourhood may not be disturbed by the bells.

In addition to the automatic mechanism for striking the quarter chimes, the hour, and playing the curfew, a separate keyboard is provided in the small room at the base of the tower in which the clock mechanism is located. It is carried in a box-like structure, shaped something after the fashion of a reed organ, and it is used every morning at 9 o'clock for playing a hymn tune by hand, and also at the regular Sunday services. This keyboard has electrical connection with the magnets in the tower and operates in the same manner as the

* *Scientific American.*

apparatus already described. In case there should be any breakdown of the electrical connections or failure of the current, each of the connecting chains between the magnets and the bells is furnished with a wooden lever which is hinged to the frame of the magnet box. This arrangement is the same as is used in the ordinary tower chimes for tune playing.

The chime consists of 10 Meneely bells, the largest of which weighs about 3,000 lbs. and the smallest 250 lbs., and to strike a sufficiently powerful blow on a bell weighing a ton and a half requires a considerable amount of force. As a

Electric Self-Winding Clock and Keyboard.

matter of fact a pull is exerted equivalent to between 3 and 4 horse-power, and to secure this the main current from the dynamo is thrown on by means of the relay box, which will be noticed attached to the wall of the tower. The cost of the current for running the motor is estimated at $1\frac{6}{10}$ cents per day, and the clock has proved to be a reliable timekeeper.

For the above particulars we are indebted to Mr. George F. Atwood, the designer of the clock, and to Mr. McCullough, the engineer of the Grace Church Settlement Plant.

AN ALTERNATING CURRENT RANGE AND POSITION FINDER.

The perfection attained by Lieutenant Fiske in the use of the Wheatstone's bridge, as applied in his range finder, has attracted much attention, and many concede that they would not desire a better range finder than this principle affords, if it were not for certain serious objections which develop only under the real test of actual practice. It is to these objections that it seems worth while giving careful attention and study; for if they are removed, the result seems certain. Among some of the objections may be mentioned the number of adjustments necessary before operating, the difficulties which most operators would meet in repairing any part which might get out of order, the sliding electrical contacts, and the necessity for a low resistance line between the two distant stations.

In comparatively recent years the alternating current in electricity has received a tremendous commercial development, which has been at least an incentive to the thorough study of the various phenomena connected with it. These phenomena include many additional things over and above what one meets in direct current flow, and some of them have such an importance, that the alternating current is finding its way continually to new practical applications for which the direct current is not adapted. In alternating current work the "inductance" of the line should be known as well as its resistance; the inductance giving rise to a "reactance," which, in some ways, has the same effect as a resistance. In fact this reactance may be, and often is the factor which controls the current, and is much more important than the resistance of the circuit itself. This is one of the phenomena which usually surprises one trained in the old school of direct current electricity, where the ohm played the all important part. It is the use of the alternating current with the Wheatstone's bridge to obtain parallelism, which is one of the essential differences in a new method which has been worked out by Dr. A. C. Crehore and Dr. G. O. Squier at the United States Artillery School (*vide Journal* of the United States Artillery, Vol. 7, No. 1); in this method nearly all the differences met with before seem to vanish naturally, and the instruments need not be extremely delicate and difficult of adjustment, but may even be roughly handled without serious injury. In the new method the resistance of the wires is of little importance, and the line resistance need not be low; indeed, iron telegraph wires may be employed. All the wires may be permanently laid and encased and never be touched, since there are no sliding contacts where a contact moves along a perfectly uniform wire, one whose range is proportionate to its electrical resistance. The use of these sliding contacts is avoided by causing a bundle of soft-iron wires to move into and out from a solenoid. In this manner the reactance of the circuit is varied, and not the resistance. It is the reactance, and not the resistance, which plays the more important part in governing the current, and thus there is a means of varying the reactance without altering the electrical circuit at all, simply through the influence of the iron in the solenoid, which is transmitted through the ether.

The method of operation will be understood by studying the accompanying figures. In fig. 1 is shown the ordinary arrangement of the circuits of a Wheatstone bridge sup-

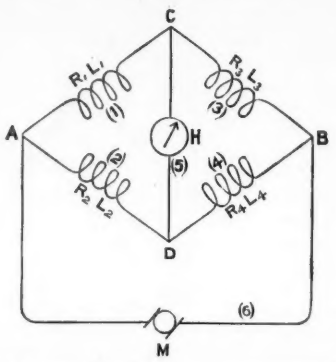


Fig. 1.—General Diagram of Wheatstone Bridge.

posed to contain, in the branch numbered 6, a source of alternating E.M.F., and in the conjugate branch, numbered 5, a milameter for detecting the presence of an alternating current. The branches, 1, 2, 3 and 4, are supposed to contain coils with inductance. A disposition of these circuits, which makes it more evident how they may be used in an actual case is illustrated in fig. 2, where the letters and

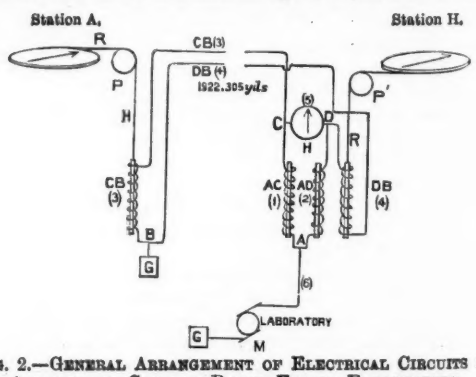


Fig. 2.—General Arrangement of Electrical Circuits for Alternating Current Range Finder Experiments.

numbers correspond. In this figure the group of circuits and apparatus near station H is located at one of the observing stations, and that marked station A at the other, while the generator may be at any convenient place, in the present instance at the electrical laboratory. A single line

runs from the laboratory to the point, A, station H, which corresponds with circuit 6, fig. 1. At A it divides along the branches 1 and 2, which are each stationary coils containing inductance, and arrives at the points, C and D, between which points the galvanometer is inserted, making branch 5. From D the circuit first passes around the coil which is to contain the movable iron core, and thence along the line to the point, B, at station A, which is connected to the ground or the return. From C the circuit passes immediately to the line running to station A, and thence around the coil with the movable iron core and to B, the return.

The method of operation is as follows:—The inductances of circuit 1 and 2 are fixed and constant, preferably approximately equal. If the iron core of circuit 3 is set in a certain position within the solenoid, then there is only one position of the core in 4, in one end of the coil, which will bring the galvanometer indication to zero. A motion of the cores is communicated to the telescopes or indicators by suspending the core vertically within its coil by means of a steel ribbon, which passes up over a pulley having a horizontal axis and then surround a large circle with a vertical axis upon which the indicator is mounted. In practice the core is moved by turning the large circle.

If the coils 1 and 2 with their cores are made exactly alike and also the coils and cores of 9 and 4, it is evident that the positions of the cores 3 and 4 will always be the same for zero galvanometer current. Hence if the large horizontal wheels are alike, the telescopes or indicators will always remain parallel for a zero galvanometer reading. The objection may be raised that it is impossible to make the coils and cores exactly alike, which must be admitted. A further consideration, however, will show that this condition of equality is not a necessary one, though desirable; for even though the electrical parts are exactly alike, the motion of the horizontal circles may be altered at pleasure by slightly changing the shape of the wheel from a true circle, or by making a cam of it. This plan is not proposed, however, as it is found in practice that the motions are alike within the error of setting by the galvanometer, even though the coils are only approximately alike. This cause, in other words, does not seem to be the largest source of error.

The above will convey a notion of the advantages in range finding to be derived from this new method. For details as to the instrument, and examples of calculations, we must refer our readers to the original paper. The paper, however, is important, inasmuch as the theoretical discussion of a Wheatstone bridge for an harmonic impressed electromotive force has a scientific interest independent of this particular application to the range finder problem.

REVIEWS.

Electric Movement in Air and Water with Theoretical Inferences. By Lord Armstrong, C.B., F.R.S., &c. London: Smith Elder & Co.

This splendidly got up volume contains a description of some interesting experiments made by Lord Armstrong on the electric discharge. The text is accompanied by extremely beautiful and accurate reproductions of the dust figures and photographs obtained during the experiments. Though we may hesitate to adopt Lord Armstrong's theoretical inferences, there can be no doubt that the accurate reproductions of his results contained in this work will be of great value to physicists.

Some of the photographs contained in this volume have already been described and discussed in the Electrical Review*, and we are pleased to find that Lord Armstrong's views are in general agreement with those which we then expressed. Lord Armstrong is strongly in favour of the theory that the electric discharge in gases and liquids consists of a movement of the nature of a smoke ring or vortex ring. The experiment which he chiefly relies on to support this view is the well-known experiment of the cotton string suspended in a tube containing distilled water. When an electric current is sent through the water, the water is carried forward with the positive current, but the string moves in the opposite direction. Lord Armstrong concludes, somewhat hastily we think, that this indicates an outer current in the tube in one direction, and a central current in the opposite direction; *i.e.*, a vortex ring circulation of the water in the tube. It seems far more probable that the movement of the string is due to the electric attraction of charges of electricity accumulated in the liquid. Quincke has shown that such charges accumulate in badly conducting liquids through which an electric current is passing. These charges are repelled by the positive pole, and may also attract the neutral cotton string. If the string were removed we would only have the current in one direction due to electric convection or electric osmose. We do not presume to deny that under certain circumstances there may be vortex motion in a fluid through which a current is passing, because there are many other experiments which support this view, but we think the cotton string experiment does not prove it.

The curious and interesting experiments of Righi † have an important bearing on the vortex theory of Lord Armstrong. Righi obtained luminous masses in partially rarefied gases which behaved exactly like smoke vortex rings. They detatched themselves from the positive pole, advanced slowly to the other end of the tube where they expanded exactly as a smoke ring does. Many of Lord Armstrong's photographs appear also to indicate vortex motion of the medium through which the electric discharge has passed.

The dust figures produced on cards placed transversely to the direction of discharge are very curious. When the discharge was made through a hole in the card, the dust rings arranged themselves concentrically round the aperture, as if they were magnetic lines of force. When the brush discharge is passed through a card covered with dust a number of small craters are formed, such as would be produced by the impact of smoke rings. The figures obtained from a negative brush are always very distinct in form from those obtained from a positive discharge. Some of the figures obtained show a curious resemblance to trees, lichens, &c. "I have already spoken of electricity as organised motion, and we have here an example of it carried apparently to the verge of life" says Lord Armstrong, a remark which appears to be more poetical than scientific. "Electricity" says the author "is identical with the inherent motion of molecules." Notwithstanding Lord Armstrong's ingenious speculations, we believe the true explanation of his experiments has yet to be discovered. To reconcile his results with what is otherwise known about the electric discharge, seems hopeless in the light of any existing theory.

CORRESPONDENCE.

The Training of an Electrical Engineer.

I have to thank you for allowing me to see a letter addressed to you by an American professor as a protest against the above article which appeared in your issue of the 9th July. As the letter is not for publication I can only enumerate the chief points made by the professor, and endeavour to reply to them.

In the first place he abuses you roundly for, as he alleges, your tendency of never missing an opportunity to "go for" professors. Whilst disclaiming any connection with the Electrical Review other than as an occasional contributor, I may say that I have never noticed symptoms of this alleged mission on your part; nor can the professor point to any "attack" on his species in the article which he finds so offensive, except what may be classed as fair criticism. He says that such "attacks" are mere waste of energy, which remark would indicate that professors are very inert objects and quite above all criticism. The professor goes on to say that the suggestions put forward as new, for the *really* practical application of theory—are decidedly ancient, and he is generally so agressive, in the usual American, patriotic, and whip-creation style—that I may be excused if I suggest that he has missed his vocation in not becoming a New York journalist. He must recollect that we do not all "think American," and that there are other places besides the States. He refers us to the prospectus of his college, and if we "have

* Vol. 36, p. 639.

† Electrical Review, Vol. 38, pp. 435, 494, 609, 684.

the fairness to look it over carefully . . . it will be evident that some professors are fully alive to the necessity of including in a technical course certain practical work . . . if the course is to be other than mere pretension," and he is so guileless that he thinks because it says so in print it must be true. Now while acknowledging that his prospectus is better than anything I have yet seen, and that the professors no doubt carry out the syllabus to the best of their power, I must say that this does not prove his case one whit, or disprove my contention—that professors are not the men to teach the practical applications of their theories. Their applications are not practical—they all savour of the preparation room—in fact they are not commercial enough.

This is no attack on professors; no man who has acquired his technical education in works could lecture on theory like a professor, and the converse holds good as regards commercial practice. I do not therefore think I was wrong in saying that my suggestion was new, and whilst I only had English institutions in my mind when writing, there is no reason to suppose that things are any better in America.

The professor further remarks that the real trouble is to be laid at the door of the governors and trustees. Now this is certainly contradictory, because from his previous remarks it would seem that there is no "trouble" at all. Following this admission up, the question arises: How far do the governors and trustees hamper the professors? Generally speaking I do not think that they interefere with the construction of the syllabus, which is arranged amongst the professors, or its carrying out and application, which are left to their individual discretion. At the same time, as I pointed out in the article, it would be better if there were some really practical men on the governing body, who would not only regulate the expenses but the professors also, if necessary, and not bolster up their institutions against all criticism.

I can only say that I have the greatest respect for professors, *per se*, and that I regret that the American professor has not written publicly so that I could have replied to him more fully and drawn attention to the excellent course of instruction at his college. I appreciate his sincerity despite his abusiveness; but he must bear in mind that professors, as well as trustees, governors, and—editors, are not above criticism.

The Writer of the Article.

A Strange Magnetic Freak.

When one makes a communication, of however trivial a nature, to the technical press, the golden rule is—receive all comments in the broadest of good temper. I must say that I do not think that the little phenomena in question can be quite so airily disposed of as your correspondent A. S. assumes, and in this conviction, I am certainly not alone.

I carefully abstained in my letter from saying more than I had evidence of facts to support, and also from plunging into speculation, intending to go somewhat more fully into the matter later on, already there is some indication that we can get away from our excellent friends table knives as such, and pass on however guardedly, to generalisations as to steel having one of its extremities pointed or edged, exhibiting north polarity at that end.

A. R. U.

August 11th, 1897.

The Postal Telegraphists.

It is to be regretted that as you could not see your way to give the telegraphists a sympathetic leader you did not at least try to hold the balance true. The most exasperating part of the treatment of the telegraphists by the officials is the determined manner in which they simply ignore plain facts. I am disappointed to find the same course pursued in your leader in last issue. The telegraphists can pass over the little sneer with which you opened, but you might have read their statements, repeated again and again to better effect, I think. If there was one thing more than another which the telegraphists have dinned into the ears of the permanent officials, the Postmaster-General, the Tweedmouth Committee, and, finally, Mr. Hanbury, it is that they are *not* asking "an increase of the maximum salary from £160 to £190," but that they are asking that the maximum of £190 granted to them by Mr. Fawcett in 1881 may still be given to them. It is a monstrous breach of contract after that maximum had been in force for 13 years for the authorities to step in and reduce it to £160, and debar everyone from rising to the old maximum without passing a technical examination. The authorities have no legal or moral right to make new conditions of employment with the present staff without obtaining the consent of the staff. They can make any bargain they wish with new entrants, but it is most unjust to impose a barrier of a technical examination on men after 20 to 30 years' service without notice at entrance.

Do not misunderstand me, though. The men do not object to the acquirement of technical knowledge. On the contrary, a very large proportion of the senior men, as well as the young men, have acquired sufficient technical knowledge to perform any and every technical duty at which they can be placed in their respective offices. In fact, no man who has not acquired such knowledge has the slightest chance of promotion without it, so far as I am aware.

As a matter of fact, however, questions are asked at examinations which no doubt it would be desirable for the candidate to know, but which at the same time would not be of the slightest use to him.

Would it not be a gross injustice to a man of 25 or 30 years' service to be rejected for promotion because he could not answer such questions? Your imaginary reply of the Postmaster-General would therefore be very unjust to the men.

The maximum of all other classes of telegraphist has been raised since 1881, save that of the £190 class. It is reasonable to suppose that the duties of that class have increased in importance in the same proportion as the other classes. Why should it then be assumed to be unreasonable to ask that the maximum of that class should be raised in the same ratio? Sixteen years ago the *Times* stated that it was not unreasonable for the telegraphists to expect a maximum of £200. Since that date the Lower Division clerks have by persistent agitation got their maximum raised by 75 per cent. Why all this official ire when the telegraphists ask for a 20 per cent. increase?

The Inland Revenue is administered by a Board of Inland Revenue men, who know the work and its true value. The result is, just salaries and a contented service. It is the misfortune of the Telegraph Service that it is administered by a body of men who know nothing whatever about the telegraph, or the value of the telegraphists' work, and who will not listen to, much less take the advice of those who do.

For a short time, about 1881, Mr. Baines, a telegraph man, had something to do with the service, and in that year we got a revision of salaries, which was far from sufficient, but which was a great improvement on the former scales of salaries. But Mr. Baines was too anxious to do justice to the telegraph men, and he was shunted elsewhere out of the way. Since then we have met with consistent and determined opposition from the permanent officials, and not until Mr. Allan's suggestion in the House of Commons of administering the department by a separate board of telegraph men, will we have a contented service, the result of humane and just views of the men and their work.

You compare telegraphists with mechanics. This is agonising! A mechanic cannot complete a single piece of work without being inspected by the foreman. Not 1 per cent. of the work of the telegraphist is seen by a foreman. Nay, I fearlessly state that *every telegraphist is his own foreman*. He is responsible for everything he does in a way that no mechanic is held responsible. The telegraphist is not even like a mechanic in their mode of payment. The latter jumps at once from the wages of a boy to the maximum of a man, but the former has to climb slowly through some 24 years to his maximum.

But worse remains. To compare telegraphists with typewriters! Surely the compositor, if not the office boy, is responsible for such a statement.

One of the greatest misfortunes from which telegraphists suffer is the utter ignorance of their work, and the value of their work, which exists not only among those who administer their Department, but among the press and public.

When a technical journal of your standard shows such a lamentable want of knowledge of the value of the work of telegraphists, what can we expect from the non-technical press and the general public? Is it not a fact that there are Lower Division Clerks in the Savings Bank Department on a scale rising to £350, entering deposits of 1s. and upwards, making out receipts, warrants, &c., all of which work is checked by a second officer? Is the work of a telegraphist not vastly superior to that?

Are there not a large body of highly-paid officials in the Foreign Office whose principal work is the translation of foreign letters? Telegraphy is distinctly a language, as difficult to learn as, say, French, and I venture to say that not at any period in the acquirement of such a language would the student find it more difficult to translate a letter efficiently than would a student of telegraphy with the same period of study to translate the language of the Morse alphabet into the English language. Why not, then, compare the work of the telegraphist with that of the highly-paid Foreign Office officials? A translator of languages can stop to consult a dictionary or a friend in a difficulty, but a telegraphist is removed from work that he is incapable of performing without help. A translator can pause to speak while at work; but woe be to the public when a telegraphist stops to speak, or is interrupted when translating the telegraph language. The wrong translation of even a portion of a letter may involve the addressee in the loss of hundreds of pounds, or plunge him into unnecessary mental trouble.

I have already taken up so much of your space that I cannot now do more than refer to the truly awful blundering of the Post-Office and other officials in 1868-70, first of all paying three-and-a-half millions too much for the telegraphs (that is ten-and-a-half instead of seven millions), and this, too, for plant which cost a vast outlay to almost wholly replace within a few years. Then the blunder regarding Press telegrams, which now costs the service over £200,000 a year; the blunder regarding railway telegrams, which costs a great many thousands; and, finally, the acceptation of thousands of pounds worth of Government telegrams annually free. As if all these were not enough to drag down the service permanently we got the 6d. rate. The officials are not to blame for that, but now the question arises, Why should the telegraphists be denied the fair treatment meted out to other large departments because of the blunders of permanent officials of the Government? No one with any sense of justice would say that they should. The country does not wish it, the House of Commons does not wish it, and with a large and increasing revenue from the Post Office as a whole, there is no just reason for denying to telegraphists the redress of their grievances.

If you should at any time be good enough to devote another leader to the telegraphists, I trust you will bear these blunders in mind, and they may temper your zeal against one of the worst paid bodies of public servants.

Telegraph.

[We are pleased to insert this letter, for we do not wish it to be thought that we bear the slightest animosity towards a body of men who are trying to better their position. Much of what our correspondent says is worthy of consideration, and a great deal is not; we shall, however, deal with his contentions and arguments fairly and impartially in another issue, but we wish him to understand very clearly that our article of last week was not penned under "a lamentable want of knowledge of the value of the work of telegraphists," quite the contrary! It was written just on the estimate the men have of themselves, or rather as their representatives choose to put it, and the mistake is theirs in allowing themselves to be classed as mere machines. It has never seemed to us that the telegraphists were exactly sure of what their grievances really consisted, and what it was that required remediable measures; or if they know what they want, their representatives have the unhappy knack of making the authorities decidedly uncertain as to the real nature of their requirements. Possibly it would be better for someone entirely dissociated with the Post Office, yet a technically qualified man, to gain a personal acquaintance with all matters of which the telegraphists complain, and present their contentions clearly and succinctly to the Postmaster-General. In any case we shall be pleased to open our columns to a thorough discussion of the grievances, and eventually the real questions at issue may possibly be made plain.—Eds. Elec. Rev.]

An Erroneous Inference.

Some misconception having arisen from a notice in your issue of the 30th ulto. under the heading of "Liquidation Notices," we beg to state that the meeting referred to is merely formal, and has to do with the final winding-up of our old company. The present new company was registered last year in order to facilitate the increase of capital to meet the requirements of our manufacturing business, the development of which has continued uninterruptedly for many years past. Although our principal business consists in the manufacture of dynamos and motors for the trade, we may mention that at the present time we have several other contracts in hand, including the supply of plant for the Norwich Electricity Company, Limited (extensions), the Northwich Electric Supply Company, Limited (new plant), and the Corporation of the City of Lincoln (new plant).

We think this will suffice to show that the voluntary winding up of our old company does not involve interruption to our business as some of your readers have erroneously inferred.

Laurence, Scott & Co., Ltd.
W. B. Sisling, *Secretary.*

POWER DISTRIBUTION IN COMPOUND ENGINES.

Dealing with this question in *Cassier's Magazine*, Mr. Henderson seems to have got hold of a rather erroneous idea. Because the forward pressure on the second of two cylinders is partly balanced by the back pressure against the first piston, he argues that the first piston is doing more of the work than credited to it. He is dealing with the mechanics of the subject, not with its thermo-dynamics, and he is applying reasoning to the mechanical question that may be correct only in the thermo-dynamic one. How does the second piston know that the steam coming to it is coming from a previous piston and not direct from a boiler, and how then can it be argued that the second piston does any less work than that commonly credited to it? It is perfectly true that the work done by the steam in the first cylinder is that represented by the area of the diagram above the line of absolute vacuum; but it is equally true that the greater part of the work is done against the resistance of the back pressure, and that the duty of the working side, *pro tem*, of the piston is largely that of pushing forward the steam occupying the space on the other side of the piston, and it is equally true again, therefore, that the net work done by each piston is that represented by the area of the conventional diagram as presented to us by the indicator. Mr. Henderson has mixed up the two subjects, and though he does not involve himself in any error as to the net final work of the engine, he does thereby gain a false idea of the net work done in each cylinder. His object is to distribute mechanical power evenly between the different cylinders, but if he wishes to do so, he must continue to calculate their respective powers from the old diagrams and not on his suggested new basis. It is difficult to see how he has arrived at his conclusions, unless it is that he has, as we suggest, got involved in the thermo-dynamic question. He goes on to state, however, that the true diagram is to be obtained by placing the indicator alternately in communication with the steam side of the H.P. piston and the exhaust side of the L.P. piston. He had better at once have simply taken the absolute vacuum. As to the L.P. diagram, he would take this in the usual manner, but calculated out on the basis only of the difference of areas of the two cylinders. It is easy to see that with this view of things firmly ingrained, the division of power must look very bad to him. But this is not the worst. By juggling in this way he finds that, quite apart from any question of internal losses and merely working with the hyperbolic formula, a compound engine is more powerful than a simple engine of same cylinder as the L.P. cylinder of the compound. For the triple expansion engine he argues

on the same fallacious lines, and for the three engines of same size by our conventional methods, he finds the powers respectively 900, 1,044, and 1,077 H.P. How fortunate it is that the addition falls off and so quickly, or we might soon have arrived at a time when by the addition of another cylinder, would have abolished the necessity of a boiler altogether. He considers he has thus solved the problem of the economy of compound working, and having by his new method found that for equal engines the power is greater in the compound engines, *ceteris paribus*, proceeds to argue in an extraordinary manner upon the back pressure, and plainly hints that it is to the wonderful principles he is the "first to discover," and in no way to the "generally assigned causes" of higher pressures, reduced cylinder condensations, or modified stresses that the economy of compound engines is due, and he mixes up economy with the supposed gain of power in a wonderful manner. He will not have it that the back pressures in the two or three cylinder compound are more than a half or a third of that in the simple engine; but he does not explain how he arrives at the conclusion, and it is difficult to follow his jumble of figures. Altogether, this is a most extraordinary paper, and the wonder is how it came to be put in type.

THE ECONOMY AND UTILITY OF ELECTRICAL COOKING APPARATUS.*

By JOHN PRICE JACKSON.

The tests of electrical cooking apparatus detailed in this paper were made with the hope of obtaining a method of cooking that would be satisfactory with a minimum risk of fire. During the past winter a serious fire, which might readily have become disastrous, occurred in one of the buildings of the college with which the writer is connected, caused by the use of an alcoholic stove. As this institution is lighted and furnished with power by electricity, it was naturally felt that such a danger should be avoided, if possible, by the use of electrical appliances. It was also desired to find out whether at least a portion of the cooking in the woman's department of the college could not be done satisfactorily by electricity.

To settle these points, I procured from the American Electrical Heating Corporation, of Boston (through the courtesy of Mr. Sayles), the following pieces of apparatus:—

One oven, 12 inches by 9 inches by 15 inches, having three heats, 3, 10, and 17 amperes, respectively.

Three stoves, of 2, 4, and 5 amperes respectively.

Two flatirons, of 1·5 and 6 amperes capacity.

One broiler, of 12 amperes capacity.

The pressure used by these is 110 volts.

The stoves are round discs of iron, on the under side of which the heating wires are imbedded in a non-conducting, non-combustible compound. The oven is a box, so thoroughly heat-insulated that the outside metal covering never reaches a temperature uncomfortable to the hand. The boiler is made of a corrugated metal surface, slightly tipped from the horizontal, with a drip groove at the lower edge for catching the meat juices. The flatirons are similar in construction to the stoves, the larger one having a low heat switch, which enables the operator to control the heat.

In all these appliances the heating coils are so arranged that the energy is largely concentrated at useful points. They are also supplied with supports and cases which will not conduct heat.

The efficiencies of the two larger stoves were obtained by heating 2 lbs. of water to the boiling point and measuring the power supplied by a calibrated wattmeter. The cooking vessels used were ordinary stewing pans, with the bases nearly the same size as the tops of the stoves. The efficiencies, considering the ratio between the amount of heat absorbed by the water and the amount received by the stove, were:—

For the larger or No. 1, 48·9 per cent.

For the next size, No. 2, 43·1 per cent.

These efficiencies could be increased by having the pans made to fit the stoves exactly, and still further by carefully covering the pans, lids, and exposed portions of the stoves with a non-conductor of heat.

When it is desired to boil water, the best plan is to place an immersion coil in a properly heat-insulated pot; such an arrangement should give an efficiency of from 90 to 100 per cent. We unluckily did not have such a coil at our disposal.

It was impossible to measure the cooking efficiency of the oven, but as it was merely warm on the outside after potatoes or bread had been baked and "done to a turn," the efficiency is high. In baking, the current was turned on and the oven allowed to heat for five minutes before the articles to be cooked were placed within, and the current was turned off from 10 to 20 minutes before the baking was done, when the heat of the oven was sufficient to complete the operation. The broiler was manipulated in much the same manner, thus utilising the greatest possible amount of heat. This electrical apparatus was used in cooking most of the meals for a family of six for several weeks.

The following table indicates the amount of cooking done for the first breakfast, dinner and supper, respectively, and may be taken as a fair average of the whole period.

All costs have been estimated on the basis of 10 cents per kilowatt hour, the average rate charged for residence electrical supply in a nearby town. The foods were not measured, as it was believed more desirable to determine whether in a long period of cooking the apparatus would prove satisfactory in a family of given size.

The largest stove is designated No. 1; the next size, No. 2; the third size, No. 3; the broiler, B, and the oven, O.

Breakfast.

Time.	Utensils.	Food.	Watts.
6.55	No. 1, on	Rolled oats	
6.55	2, on	Coffee	844
7.45	3, off		
7.45	B, on	Beefsteak	1,505
7.55	2, off		1,150
8.05	B, off		

Kilowatt hours, 1·355 Cost, 13·55 cents.

Dinner.

10.25	No. O, on	Beef roast	
10.35		Potatoes	1,610
11.14		Pie	
11.46	1, on	Asparagus	1,990
12.05	O, off		
12.05	2, on	Coffee	1,180
12.11	B, on	Toast for asparagus	2,200
12.29	1, off		1,835
12.32	B, off		
12.32	2, off		

Kilowatt hours, 2·98 Cost, 29·8 cents.

Supper.

4.59	No. 1, on	Cocoa	630
5.15	2, on	Potato cakes	1,010
5.10	B, on	Omelet	2,100
5.22	2, off		1,700
5.26	B, off		
5.26	2, on		1,130
5.43	2, off		
5.44	1, off		640

Kilowatt hours, 8·39 Cost, 8·39 cents.

Four pies can be baked in the oven at an expenditure of ·62 kilowatt hours, and a cost of 6·2 cents or 2·05 cents per pie. Two large loaves of bread were baked with the current on the oven 50 minutes, at an expenditure of 1·22 kilowatt hours, a cost of 12·2 cents, or 6·1 cents per loaf. Four rather small-sized loaves could have been as readily baked. Biscuits with about the same expenditure of energy as in the case of pies. The broiler utilised about the same amount of energy for all kinds of meat.

The result of the whole series of meals was a cost for electricity of 13·1 cents per meal. The heating of water for washing the dishes took an additional ·35 of a kilowatt hour per meal, which raises the cost to 16·6 cents per meal.

To determine the relative cost of cooking with electricity and coal, the same foods were cooked on the No. 8 Othello coal stove ordinarily used by the family. The coal was carefully weighed. The results gave an average of 12·6 lbs. per meal, which at $5 per ton gives a cost of 3·15 cents per meal.

The result shows the cost of cooking by coal about 19 per cent. of the cost of cooking by electricity.

* A paper presented at the fourteenth general meeting of the American Institute of Electrical Engineers, Eliot, Me., July 26-28th, 1897.

Ironing was done for the same household a number of times. The heavy articles were done with the large iron; while for fancy dresses and small articles the small iron was used. The average time taken was four hours, and the expenditure of energy in kilowatt hours was 2·27. This made the cost of the ironing 22·7 cents.

An equal number of tests was made using the coal range, the fuel being carefully weighed. For the same size wash, the ironing took five hours at a cost of 12·25 cents. This shows the cost of energy by the use of coal to be 54 per cent. of that by electricity.

The results of the cooking tests seem to indicate that, for the ordinary cooking of a family for the whole year, the expense would be larger than would be ordinary acceptable, notwithstanding the great advantages in other respects. However, in the following classes their utility should be great:—

1. For light housekeeping, such as is practised in small city apartments, or in many large houses during the summer months, no other method presents so many desirable features. The dirt of coal and ashes, disagreeable gases and abnormal temperatures due to a coal stove are entirely obviated. For such housekeeping, a disc stove using 500 or 600 watts and a broiler using about 1,200 watts, would be sufficient for a small family, and would cost from $20 to $30. A tea kettle or immersion coil might be added at a cost of from $6 to $10. A special pair of wires would of necessity have to be run into the cooking room from the house or apartment supply mains. The latter would ordinarily warrant the extra call that would be made upon them in this way. For similar purposes coil oil, gas or gasoline, are frequently used, but with the inherent disadvantages of greater heat in the room, offensive odours, comparative uncleanliness and danger.

2. This form of cooking apparatus could be used with facility in boarding houses and restaurants for purposes which require an even temperature, such as is needed in baking griddle cakes, boiling eggs, &c.

3. Where electricity is available, nothing could be more convenient than a small electrical stove, requiring 300 or 400 watts, for the many uses to which, at present, the alcohol flame is put, such as the afternoon tea kettle, chafing dish, toaster, &c. This use of alcohol is most unsafe as regards danger from fire, and could well be discarded for electricity, which is absolutely safe when properly installed, as well as being more convenient and better in other respects.

4. In the shop, the glue pot, solder pot, brazing iron, &c., can be heated advantageously by electricity, and one of the most gratifying consequences of our experiments has been the decision to put such an equipment in our college shops.

5. The test of the electrical flatirons showed them more economical than the old form, when the saving of labour is taken into account. Not only is there a saving in time, but the severity of labour is much lessened. Our experience was that a laundress who had used an electrical iron would be exceedingly unwilling to go back to the old form.

A small flatiron of 2 or 3 amperes attached to the ordinary lighting fixture in a dressing-room is a great convenience; and with an electric tea-kettle and curling-iron are destined to become essentials in the modern home.

Concerning the questions whether the use of electricity had proved satisfactory in its operations in the cooking tests described, the housekeeper in charge said: "The instruments were excellent in every respect. We were able to cook more rapidly, to keep the heat at just the right point, and could readily prevent over-cooking or under-cooking. While we were using electricity, every dish was perfect. When I think of these advantages, and of the cleanliness and convenience of the utensils, I sincerely hope that some of them at least may be retained in the house permanently."

The general results of the tests were of such a nature that the writer is warranted in the belief that if central station managers would more generally introduce exhibition equipments of these domestic utensils, a new call on their station capacity would develop, of which the larger proportion would be during the light load periods.

I wish to acknowledge my indebtedness to Mr. Rudolph F. Kelker, of Harrisburg, Pa., for his valuable aid in carrying out the work briefly described above.

COMMENTS ON THE NEW INSTITUTION WIRING RULES.

A VALUED correspondent sends us the following:—

1. *Sectional Area.*—The innovation of making this proportional to the heating effect plus the temperature of the air—that is, a total temperature limit—is excellent on paper, but it remains to be seen whether the practical man will so soon give up the 1,000 amperes per square inch. At the same time the table is very useful, and the currents under column 4 will, if allowed by insurance companies, effect a small reduction in the cost of wiring. The idea of putting 13 16-C.P. lamps on a 3/20 circuit where only seven can go now, seems rather heretical. The question is whether jerry wiremen will not now halve the sections of their wires, irrespective of the locality or temperature of same. Would it not be better if the cable manufacturers would get out a new specification of insulation for higher temperatures?

2. *Insulation.*—This has evidently been carefully prepared by a cable expert, but the tests for flexible cord conductors have the mark of the laboratory on them. Should not pure rubber flexible cord be given up altogether? It is only an encouragement for wiring fittings badly.

3. *Jointing.*—No mention is made of vulcanised joints, and as pipe work is subsequently referred to—this is important, as there are various ways of making them, some better than others.

4. *Draw in systems* are mentioned for the first time, but attention might have been drawn to the fact that they lend themselves to the ideal system in the paragraph before better than casing. Some rules might be laid down for draw in systems.

Conductors spaced from walls.—It is well that these are prohibited unless armoured.

5. *Conductors drawn into channels.*—Query, how about the action of lime on the insulation?

6. *Jointing on to switches.*—More attention should be drawn to the fault of allowing braiding or other absorbent protection to touch the brass contacts or even the porcelain of fittings, as this is a frequent source of leakage.

7. *Damp Places.*—The bases of switches, &c., may be dipped in paraffin wax to ensure good insulation; or in case of pipe-work, where there is always a good "earth" ready to cause leakage, the switches may be cemented to unvarnished blocks, thus avoiding the use of fixing screws.

Switches with screw on covers should not be allowed. The thread on the porcelain frequently grinds the brass off the cover, and fills the interior and base with brass dust.

Wiring of fittings should have been dealt with more strictly. Should not all fittings be insulated by using ebonite nipples for the lamp-holders?

8. *Switches.*—No mention is made of the objectionable habit of letting the current go through the spindle or pin. This should not be allowed.

9. *Switchboards.*—I am glad to see that the importance of front connections is recognised.

No mention is made of bushing all fixing-screws. This is very important for switchboards insulation as moisture often condenses on the slate or marble.

10. *Fuses on Tapered Mains.*—Switches, with fuses under the same cover as tumbler switches, should not be allowed.

Connectors in Floors are dangerous things as regards leakage, and should not be allowed.

11, 12, 13 and 14, hardly seem to call for comment, as they do not often come within the province of other than large contractors.

15. *Insulation Test.*—This seems very low, and it is questionable whether large supply companies will adopt it.

Generally.—It would be interesting to know how the tables are arrived at; that is to say, the origin of the equations on pp. 13—14. These are not likely to be used by busy men.

Will these tables hold good for large alternating currents, where the current flows mostly at the outside of the conductor?

No mention is made of the bad insulation of some incandescent lamps between contacts and collar, thus putting the installation to earth through the fitting.

LEGAL.

Mackie *v.* Bullard.

Mr. William Mackie, electrical engineer of 77, Turnmill Street, sued Mr. Duke W. Bullard, of 122, Newgate Street, at the Clerkenwell County Court before his honour Judge Meadows White, to recover the sum of £40 5s. 3d., in respect of goods sold and delivered. It appeared from plaintiff's evidence that in November last, a Mr. Thompson ordered a motor from him, saying it was to be fixed to a cab that defendant was having built. The motor was supplied, and the invoice made out to defendant, but posted under cover to Thompson. William Thompson, in the course of his evidence, stated that he was the inventor of some motor propelling gear, and in November he was trying to form a syndicate in order to work his patents. Mr. Bullard offered to finance him, and had actually paid a number of small accounts in connection with the business, but he would not pay for the motor. The defendant contended that he never authorised Thompson to pledge his credit. It was quite true that he had paid a number of small accounts in respect to the venture, but because he had divested himself of his hat and coat, it was no reason why he should discard all his clothing. He had actually paid a cheque for £50, especially for the motor. Eventually his honour found for the plaintiff for the amount claimed.

The Woking Electric Supply Association *v.* Hunt.

This case came on for hearing at the Guildford County Court on Thursday last week, before his honour Judge Lushington, and was a claim for £4 7s. 10d., in respect of electric current supplied to defendant. The defendant disputed the correctness of the charge. A clerk who appeared for the Association stated that there was a meter which worked automatically, and it was tested in April last. The account against the defendant was for electricity supplied from December, 1896, to March, 1897, and the meter was tested immediately after his complaint. His honour said before giving his decision, he should like to have evidence from the person who tested the meter, therefore the case was adjourned until the next court.

Gore *v.* National Telephone Company.

This case came before Mr. Under-Sheriff Burchell and a jury at the Sheriff's Court, Red Lion Square, last week, being remitted from the High Court for the assessment of the damages due to the plaintiff for personal injuries. Mr. Watson Moyses, who represented the plaintiff, Mrs. Elizabeth Ann Gore, coffee-house keeper, of York Road, Wandsworth, aged 62, said she was in her garden at the rear of her house on May 2nd, when workpeople in the employ of the National Telephone Company were mending some wires overhead. One of these wires suddenly fell to the ground, coiled round the plaintiff's waist, and in rebounding dashed her against some stone-work in the garden. The plaintiff received permanent injuries, and had been under the doctor's hands ever since. Since the occurrence the plaintiff had had to give up her business, and, to make matters worse, her husband was a confirmed invalid. The coffee-house business was a very lucrative one, and was the only support of the family.

Nellie Gardner said she went to Mrs. Gore's assistance when the wire fell. Mrs. Gore was screaming. She was on the rockery or grotto, and the wire was coiled round from her waist to her feet.

Plaintiff, in her evidence, substantially corroborated the opening of counsel. She added that the coffee-house business was a very good one—one that brought in a very good income. It, however, wanted a lot of looking after, and since the accident she could not personally manage the business. She estimated her profits at £3 weekly.

Dr. Kempster, divisional surgeon of police, gave evidence as to the plaintiff's injuries. From his experience he knew that a falling telephone wire was a most dangerous thing. Its pressure would be enormous. In one case he had to attend a man who had his head cut completely off by a falling wire.

Mr. Compton Smith, for the defendant company, contended that the damages had been exaggerated, and urged that the plaintiff, after she had been injured, might have got someone to manage the business for her.

The jury assessed the damages at £250.

Bankruptcy Proceedings.

The creditors of Frederick Griffin, electrical engineer, late of Clarges Street, met last week at the London Bankruptcy Court, and, in the absence of any offer, left the case in the hands of the Official Receiver to be wound up in bankruptcy. In the early part of 1895 the debtor joined Mr. F. L. Benson in the business of an electrical engineer, and premises were taken at Clarges Street with a view to working a patent electrical accumulator, or secondary battery. Arrangements were made for money to be advanced by a syndicate to work the patent with a view to floating a company to acquire it if it proved satisfactory. That result, however, did not eventuate within the allotted time, and the debtor then transferred his interest to his partner and took up a cycle company's agency, in connection with which he sustained considerable loss. He attributes his failure to bad debts and the expense of working up a new business. He returns his liabilities at £1,769, and his assets at £158, subject to preference claims of £87. The Chairman remarked that the debtor had been insolvent for some time, and his creditors had exercised a great amount of forbearance towards him.

BUSINESS NOTICES, &c.

Electrical Wares Exported.

Week Ending Aug. 17th, 1896.	£	s.
Aden. Teleg. cable	1,6809	0
Alexandria. Teleg. mat.	60	0
Archangel	88	0
Beira. Teleg. mat. ...	757	0
Bombay	30	0
Brussels	68	0
Calcutta	1,699	0
Cape Town	251	0
" " Teleg. mat.	151	0
Copenhagen	52	0
East London	550	0
Flushing	10	0
Sandia	635	0
Hong-Kong	16	0
Iquique	25	0
Libau	64	0
Malta	30	0
Melbourne	22	0
" Teleg. mat.	890	0
Port Elizabeth	393	0
Rosario. Teleg. mat. .	1,122	0
Shanghai	70	0
Singapore	1,116	0
Stockholm	23	0
Sydney	714	0
Wellington	328	0
Total	£25,973	0

Week Ending Aug. 17th, 1897.	£	s.
Adelaide	126	0
Aden. Teleg. mat. ...	30	0
Alexandria. Teleg. mat.	238	0
Auckland	41	0
Bombay	151	0
" Teleg. mat. ...	438	0
Boulogne	32	0
Brisbane. Teleg. mat...	438	0
Buenos Ayres	125	0
Calcutta	326	0
Cape Town	1,358	0
Christchurch	19	0
Cologne	25	0
Colombo	21	0
Durban	39	0
Flushing	78	0
Genoa	8	0
Gibraltar	1,525	0
Hamburg	145	0
Malmo. Teleg. mat. ...	27	0
Malta	85	0
Melbourne. Teleg. mat.	1,536	0
Montreal	41	0
Napier	28	0
Newcastle	18	0
Port Elizabeth	29	0
Saigon	50	0
Santio. Teleg. mat. ...	716	0
Singapore	5	0
Stockholm. Teleph. wire	15	0
Sydney	275	0
Wellington	417	0
Tokolama	1,158	0
Total	£9,565	0

Amalgamation.—The *Walsall Observer* understands that the business of Messrs. Bayley Bros., of Selborne Works, Walsall, has been sold to the Edison & Swan Company.

Cricket.—Wandsworth *v.* Shoreditch. Representatives of the above electric supply stations met on Saturday, the 14th, at Hyde Farm, Balham, and a very pleasant game ended in favour of Wandsworth, 86 to 57.

Deptford.—The London Electric Supply Corporation, Deptford, have placed an order with Messrs. Plenty & Son, Limited, for an engine of 2,010 horse-power. Messrs. S. Z. de Ferranti have received an order for a 1,500 kw. plant for 1896.

Exhibition at the People's Palace.—In consequence of the great success of the Industrial Exhibition held at The People's Palace last year, it has been decided by Mr. A. F. Hill's and the Executive Committee to open an exhibition in October next, illustrative of trade in all its branches, and of inventions brought to light during the Queen's reign. The adjudicators in the various sections will be appointed from the largest and most important firms in the various trades competing. Medals specially designed will be awarded to manufacturers and individual artisan exhibitors.

Instructor in Electrical Engineering Wanted.—It will be seen from our "Official Notices" that an Instructor in Electrical Engineering is required at the Technical College of Ceylon.

Sale by Tender.—Mr. A. G. Robertson, 13, Basinghall Street, the receiver for the debenture-holders in the Electrical Manufacturers, Limited, is prepared to receive tenders for the purchase of the stock-in-trade and furniture of the company.

Staverton.—The Acetylene Light Syndicate are establishing works at Staverton, near Trowbridge, for the manufacture of calcium carbide.

The Stopping of Engines in Emergency.—Messrs. A. F. Stone & Son, of Sheffield, say with reference to the bursting of the fly-wheel in the Tacoma Railway Co.'s power-house, described in our last issue, they are at present engaged in fitting up in several works in Sheffield an effective and successful means for instantaneously closing the stop-valves of the steam-engines in case of accident. The *electrical part* of the apparatus has been recently brought out by them to meet the very necessity mentioned in the paragraph referred to, and a patent has been applied for. The principle of the apparatus seems to be the breaking of an electrical cricuit which permits a weight to fall and close the valve. In the case of an engine similar to that of the Tacoma Railway Co.'s, a special form (or even an ordinary form) of electrical "push" may be used, which latter is designed to prevent the mischievous stopping of the engine in factories where many persons are employed.

Yacht Lighting.—The Northern Electrical and Ventilating Company, of Liverpool, have just completed an electric light installation on board the Prince of Naples's steam yacht *Iela*, so named after the beautiful Princess of Naples, who attracted so much attention at the recent Jubilee celebrations. The Prince and his party, who have now started on a trip round the world, have in-

formed the firm that they are highly delighted with the manner in which the work has been carried out, and were much interested in the deep sea lamp. The installation consists of combined engine and dynamo, and a complete set of accumulators for saloons and state rooms, which rooms have special arrangements for lowering and raising the lights as required. The whole of the work has been carried out under the personal supervision of Mr. C. P. L. Titherley, the company's engineer.

The Crytal Electric Lamp Co., Limited.—In our note on this company with reference to the winding-up, we ought to have added that the company has been reconstructed.

ELECTRIC LIGHTING NOTES.

Aberdeen.—Some trials are to be made with arc lamps for street lighting.

Aldrington.—Powers are to be applied for the lighting of Aldrington, Glasgow.

Bangkok.—A correspondent of the *Birmingham Daily Post* says:—I have just had given me by a prominent authority the following particulars of a most important concession which has been assigned to an American firm, and which, seeing that the King of Siam is still with us, should serve to increase the activity of British capitalists and manufacturers. The concession is for a period of 10 years, and gives the right to the concessionaires to light by electricity the whole of Bangkok and suburbs, the latter comprising an area of something like 1,000 square miles. The concession is to be renewable for a second period of 10 years at the option of the concessionaires.

Barking.—The Urban Council has resolved to ask for tenders for lighting plant.

Bootle.—Upon receiving the approval of the Board of Trade on the system proposed to be adopted by the Town Council Mr. T. L. Miller will be instructed to prepare full and detailed drawings.

Brechin.—An agreement between the town authorities and Messrs. Edmundsons for the lighting of the town is likely to be adopted.

Coatbridge.—The local lighting company cannot agree with the Town Council as to the price to be paid for street lamps. The company offer, provided ten lamps are used, to make the price £20, and if less than this number £25 each, but this does not suit the Council.

Coventry.—The City Council on Tuesday had another long discussion upon the recommendation of the Electric Light Committee to extend the works and mains and provide for public lighting of the streets. The Chairman of the Gas Committee (Ald. Andrews) fought the proposal strenuously, and ultimately the scheme was referred back for modification.

Darwen.—At a meeting of Electric Lighting Committee held August 11th it was resolved to recommend the following proposals for adoption, viz., That the direct driving system be adopted. That the distribution be made by a direct current supply on the three wire system at a pressure of 440 volts, with a 220 volt service to consumers, with suitable accumulators. That the town clerk forthwith advertise for a borough electrical engineer, at a salary of £200 a year, who will be on the scene during the whole progress of the works from the start to the finish. That after the specifications have been drawn up for the electrical work they be submitted to such consulting engineer as the Committee should select, for him to report upon the same prior to the contract being let. That the surveyor be instructed to prepare the necessary plans for erecting the central station, in order that no time may be lost in applying to the Local Government Board for their sanction to the borrowing of money for carrying out the undertaking.

Electrical Ventilators.—The Gaiety Theatre has been fitted in all parts with electrical ventilators.

Gravesend.—At a meeting of the Gravesend Town Council on Tuesday, a long discussion ensued in connection with the notifications which have been given by electric lighting companies to apply for provisional orders. The Town Clerk said the applications ranged themselves into three classes:—(1) The Great Western Electric Light and Power Company, Limited, who had given statutory notice of their intention to apply to the Board of Trade, but had not answered any of the Town Clerk's letters on the matter. (2) The Electric Supply Corporation, Limited, of Mansion House Buildings, London, E.C., who have given statutory notice, and appeared to be promoted by Crompton & Co., who have already lighted other towns, and propose an agreement, under which the Corporation should at their expense obtain a provisional order, to be transferred to the company, who would undertake to erect the necessary works and to produce and supply electricity, charging 4d. per unit for public lighting. (3) Edmundson's Electricity Corporation, Limited, of 19, Great George Street, Westminster, who would also defray the cost of the Corporation obtaining a provisional order, to be transferred to them or a local company formed under their guidance, the charge for public lighting to be 4d. per unit. Both the last mentioned companies offer terms as to the purchase of the undertaking by the Town Council at the end of certain periods. The discussion of the terms was adjourned, the Lighting Committee being empowered to enter into negotiations with any of the companies, with a view to eliciting further particulars.

Glasgow.—Sites have been purchased for new electricit y works.

Gourock.—The Burgh Commissioners have decided to apply for a provisional order.

Grimsby.—The Town Council have resolved to take advice on the advisability of transferring their provisional order to a private company.

Halifax.—Arc lamps are to be fixed on some of the tramway poles.

Ilford.—The Electric Lighting Committee reported that they had considered the advisability of taking steps to obtain a provisional order for lighting the town by electricity, and recommend that the Council advertise for qualified engineers to advise the Council as to the best mode of procedure; they to state what public town they have dealt with in the like manner, to name what fee they would charge for reporting upon the lighting of the central and south wards only. This recommendation was adopted.

Llandrindod.—The works of the local electric lighting company have now been completed. Private lighting and street lighting is being done.

Leeds.—The Kirkgate Market is to be electrically lighted.

Lighting, Loyalty, and the Phonograph.—At a meeting of the Weaverham Parish Council some days ago, the lighting of the district was discussed, and Mr. Fleming submitted a scheme for using the River Weaver for driving the dynamos. The local paper says that Mr. Fleming at the close of his speech produced a phonograph which gave the music of a band. "The meeting closed with the National Anthem, which was repeated by the instrument."

Lighting of Waterloo Bridge.—As a return for the wayleave for their mains across Waterloo Bridge granted by the London County Council, the Charing Cross and Strand Electricity Supply Corporation have agreed to supply light to the lamps on the bridge and maintain the same free of cost to the Council providing that only an amount of energy shall be required as may be reasonably necessary for the efficient arc lighting of the bridge.

Liverpool.—Last week some interesting evidence as to the growth of electric lighting in the district was laid before Major General Crozier, who, it will be remembered, held an inquiry into the proposal of the Corporation to borrow £100,000. When the Corporation came into possession in 1896 the number of lamps was 41,500. After six months' working it had increased to 52,500, and on July 1st in the present year the number was 63,162. To show how carefully and skilfully the undertaking had been carried on by the Committee and the engineer, in December, 1896, after six months' working, there remained a surplus of £11,000 to the credit of the Corporation. In spite of this reduction in the price, however, the income was still progressing in a satisfactory way. Roughly speaking, the net profit for the six months ended June 30th last was nearly £13,000, out of which interest and sinking fund had to be paid.

Liverpool.—At a meeting of the Liverpool United Gas Light Company, the chairman said that in spite of all the opposition of the electric light the past year had been a record one. The quantity of gas they had manufactured and sold was the largest on record as far as he knew in the history of the company.

Macclesfield.—The Electric Supply Corporation have given notice of their intention to apply for a provisional order.

Newington.—The Newington Vestry on Friday last gave instructions to Messrs. Kincaid, Waller and Manville to prepare detailed drawings and specifications of the electric generating station and plant required, in order that the Vestry may as soon as possible proceed with a scheme for putting into operation the Newington Electric Lighting Provisional Order, which has passed through both Houses of Parliament, and received the royal assent without amendment.

Newport.—The Electricity Committee reported that the tenders received for the supply of machinery in connection with the extension of the electric light works had exceeded the estimate by £5,000. It was therefore necessary to apply for permission to borrow £5,000 more than was at first intended. This has been agreed to.

Partick.—The Town Commissioners have decided that they are prepared to transfer their lighting order, and they will oppose any applications for powers.

Reddish.—The District Council has decided to oppose the application of the Reddish District Electric Lighting Company for a provisional order.

Torquay.—The question of lighting the Town Hall and Bath Saloon with electricity has been referred to the Finance and Bath Saloon Committees.

Woodstock.—The Woodstock Town Council have refused the offer of the gas company to light the town, and have instructed the Lighting Committee to procure the opinion of a practical engineer as to the practicability and probable expense of an electric light installation.

ELECTRIC TRACTION AND MOTIVE POWER NOTES.

Bedford.—The *Bedfordshire Times* urges the Bedford Town Council to adopt electric tramways.

Belfast.—At the last meeting of the local tramway company, the chairman speaking of the recent proposals to adopt electric traction said on account of the attitude of the Corporation all the negotiations had come to a deadlock; in fact, they were at an end.

Bristol.—The daily Press of the Bristol district says there is some prospect of the battle between the Corporation and the tramway company being fought over again.

Compressed Air Systems.—A writer in the *Street Railway Journal* says the expense of installing this system does not differ materially from that of the electric trolley system. The compressed air power plant can be installed for the same amount as an electric power plant, and the cars, while costing somewhat more than the trolley cars, are more than offset, it is claimed, by the expense of the trolley line itself. As compared with the underground trolley, there is, of course, a saving of the interest and maintenance of the conduit, a sum which would in itself exceed in many cases the whole motive power expense of the compressed air car.

Dublin.—A difficulty has arisen between the tramway company and the Dublin Corporation with reference to the relaying of the tramway system in the city under the recent Act of Parliament. The City Engineer raised objections to the class of standards for the electric trams which the tramway company proposed to erect, and by his certificate he has stopped the works under the provisions of the late Improvements Act. The questions raised are not of a serious kind. However, it is satisfactory to see that Mr. Harty is so carefully looking after the interests of the citizens. The whole question was considered on Friday last at a meeting of a special committee appointed to take charge of the matter, and certain queries were sent to the tramway company, which will, no doubt, receive a satisfactory answer.

Electric Traction in Spain.—A concession has been granted for a projected electric tramway in Madrid between the Puerte de Vallecas and the Puerta de Hierro.

Gillingham (Kent).—At a meeting of the Gillingham Urban District Council on Saturday, Mr. Fraser had an audience with the Council as to the proposed establishment of an electric tramway in the district, in which scheme the co-operation is being sought of the local bodies. Mr. Fraser said the promoters were prepared to spend £100,000 on the undertaking. The Council resolved to consider the proposal.

Halifax.—It is said that the Board of Trade have approved of the system of electric traction to be adopted by the Corporation.

Manchester.—A Special Committee of the Manchester Corporation have decided to recommend the Council to take over the tramway system.

Motors in Brewery Work.—The Anglo-Bavarian Brewery at Shepton Mallet are utilising electric motors for pumping purposes.

The Tramways Question at Liverpool.—The *Liverpool Post* says: "It is understood that an effort is being made to arrange a workable understanding between Sir Arthur Forwood, M.P., and the majority of the Tramways Committee, preparatory to the former withdrawing his resignation of the chairmanship. Some members of the committee who are opposed to Sir Arthur Forwood appear to regard their policy as definite, but others favour a compromise. Should the efforts to secure a *modus vivendi* not succeed, the matter will have to be threshed out at the next Council meeting.

TELEGRAPH AND TELEPHONE NOTES.

Telegraphic Interruptions and Repairs:—

Cables.	Down.	Repaired.
Brest-St. Pierre (Anglo, 1869)	April 6th, 1893 ...	...
West Indies—		
St. Croix-Trinidad ...	Nov. 30th, 1896 ...	...
Cayenne-Pinheiro (Brazil)	July 22nd, 1897 ...	...
Amazon Company's cable—		
Parintins-Itacatiara ...	May 5th, 1896 ...	...
Obidos-Parintins ...	Dec. 7th, 1896 ...	...
Zanzibar-Mombassa	July 13th, 1897 ...	...
Cyprus-Latakia	July 23rd, 1897 ...	...
Aden-Zanzibar	July 28th, 1897 ...	...
Landlines.		
Trans-Continental line beyond Masol	March 12th, 1896 ...	...
Carthagena - Barranquilla (Columbia)	July 4th, 1896 ...	...
Siberian landlines—		
Tschita-Kaidalowo (all lines).	Aug. 9th, 1897 ...	...
Chio-Syra	April 19th, 1897 ...	Aug. 12th, 1897.
Saigon-Bangkok ...	Aug. 11th, 1897 ...	Aug. 12th, 1897.

April 19th, 1897.—During war between Turkey and Greece, cable between Trieste and Corfu cannot be used for messages for Turkey; they must be sent *vid* Bosnia, Montenegro and Servia.

The Ottoman Government announces that messages in secret language may not be sent to the Greek Minister and Consul in Turkey. They are to be sent in plain language.

April 21st, 1897. — The Greek Administration prohibits secret language for private telegrams for Greece.

April 25th, 1897.—The Hellenic Administration notifies delay on press messages emanating from Greek provinces by reason of the lines being blocked.

April 26th, 1897.—The Ottoman Administration notifies that, until further notice, private telegrams for Crete must be written only in plain Turkish or French language.

August 5th.—Eastern Company announce owing to interruption of East Coast route, messages for South Africa are subject to serious delay.

August 7th.—Communication with South and East Africa temporarily interrupted by both routes.

August 10th.—Eastern Company announce that traffic for South and East Africa is still subject to serious delay.

The Telephone in Germany.—The *Glasgow Herald* publishes the following: "The new Postmaster-General, von Podbielski, in an interview with the *Flensburger Nord deutsche Zeitung* on the subject of the desired and proposed reforms to be made in his Department, said that it was his intention to proceed with these reforms in a strictly systematic manner, and that he would not listen to any attempts to bring to his notice isolated cases of maladministration, as that would only hinder him in his general work of reforming the whole system. As a general rule, Herr Von Podbielski will take up the position that for all advantages granted, and especially in cases of preferential treatment, the cost is not to be borne by the general public, but entirely by those to whom such advantages are given. In the course of next year he proposes taking up the question of reform in the matter of letter and newspaper postage, and also of the telephone service. With regard to the last, very important reforms are to be introduced, and it has already been definitely decided that a reduction of the telephone charges in general must undoubtedly be attempted; but here also Herr von Podbielski intends to follow his rule of causing those who make special claims on the Department to pay special rates. He gave as an example the Stock Exchange, which, during Exchange hours, practically monopolised certain wires without paying anything for so doing. How the lowering of the rates is to be done depends upon certain special circumstances, and an important question follows, viz.: Who are to be employed to work the telephones? That is to say, can a larger proportion of women, who work for a lower wage, be employed for this purpose? Herr von Podbielski has already taken steps for procuring information as to the arrangements in force in other countries. Four officials have been sent to Sweden to study the telephone system there. It is well known that Stockholm has the most extensive telephone system of any city in the world; there are two separate services there—the Almanna and the Riks telephone, the latter being the Government system. The Almanna system's subscription covers a radius of 43 English miles around Stockholm, and the company has besides 2,500 instruments outside the city, with which the subscribers in Stockholm can be connected free of charge. The total number of subscribers is 15,500, or one telephone to every 18 inhabitants. The company supplies private houses with telephones for M.40 [£2] per annum, while offices and shops have to pay M.66 [£3 6s.]. The cost of fixing up the instruments has certainly to be added to these rates, but in spite of this there is no town in the world where the telephone is doing so well as in Stockholm. The Government telephones, which alone connect Stockholm with the provinces, and with Norway and Denmark, have in Stockholm and neighbourhood 4,000 subscribers; the cost is M.54 [£2 14s.] per annum. For speaking at public call offices, some of which are automatic, 10 ore [fully 1d.] is charged. Judging from the great interest Herr von Podbielski takes in the Swedish systems, we expect that he will follow them in many of the reforms that he has in view.

CONTRACTS OPEN AND CLOSED.

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Barking Town.—The Town Urban District Council require tenders for electric lighting. Particulars will be found in our "Official Notices."

Belfast Harbour.—August 23rd. The Harbour Commissioners are prepared to receive tenders for the supply of 2 dynamos, 1 switchboard, 100 arc lamps, 100 tubular masts, 100 isolating switches, mains and junction boxes, or portions thereof. Tenders to be addressed to Secretary to the Belfast Harbour commissioners. See our "Official Notices."

Derby.—August 30th. The Corporation want tenders for the supply of one alternating current dynamo and engine, also a continuous current dynamo for the present engine. Electrical engineer, Mr. J. E. Stewart. See our "Official Notices."

Ludlow.—September 1st. The Corporation of Ludlow offers a prize of £20 for the best and most economical scheme of electric lighting for the borough. Town Clerk, Mr. John Herbert Williams. Should the Corporation employ the engineer whose scheme is awarded the prize to carry the work out, then the £20 will merge in commission.

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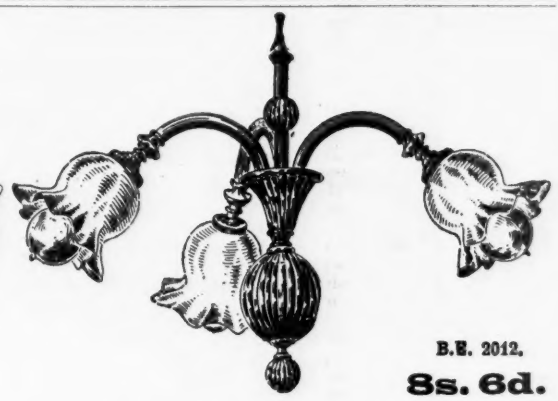

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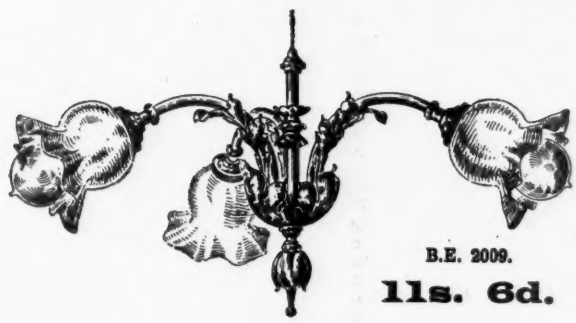

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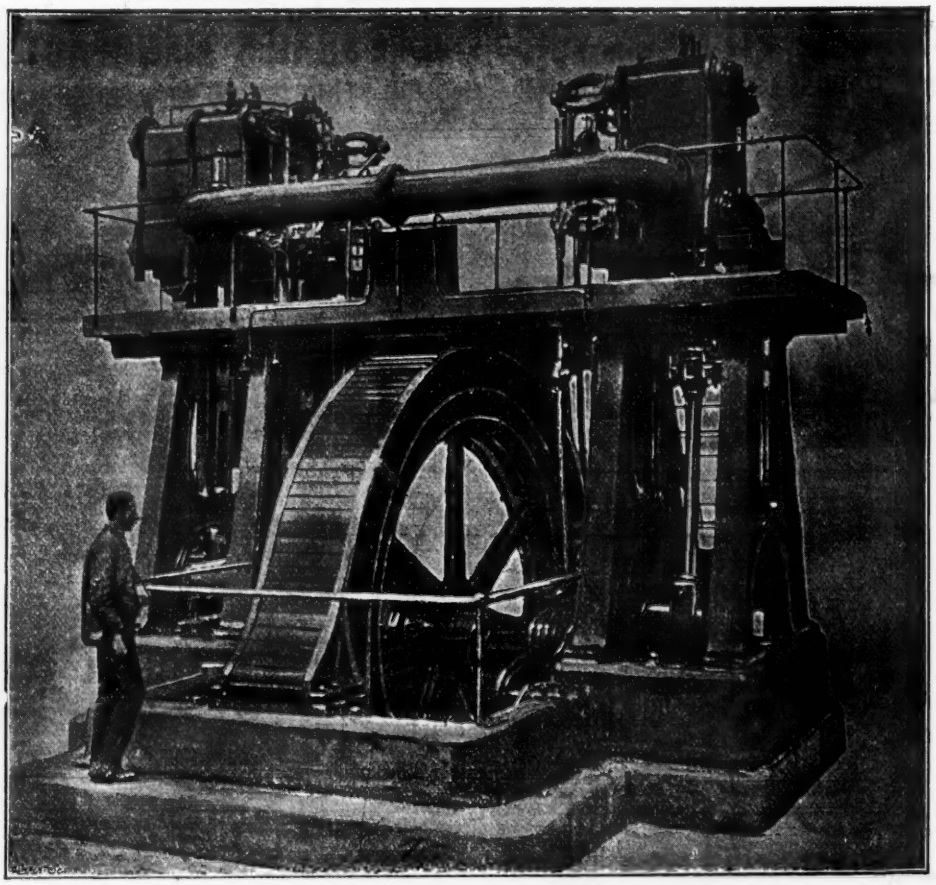

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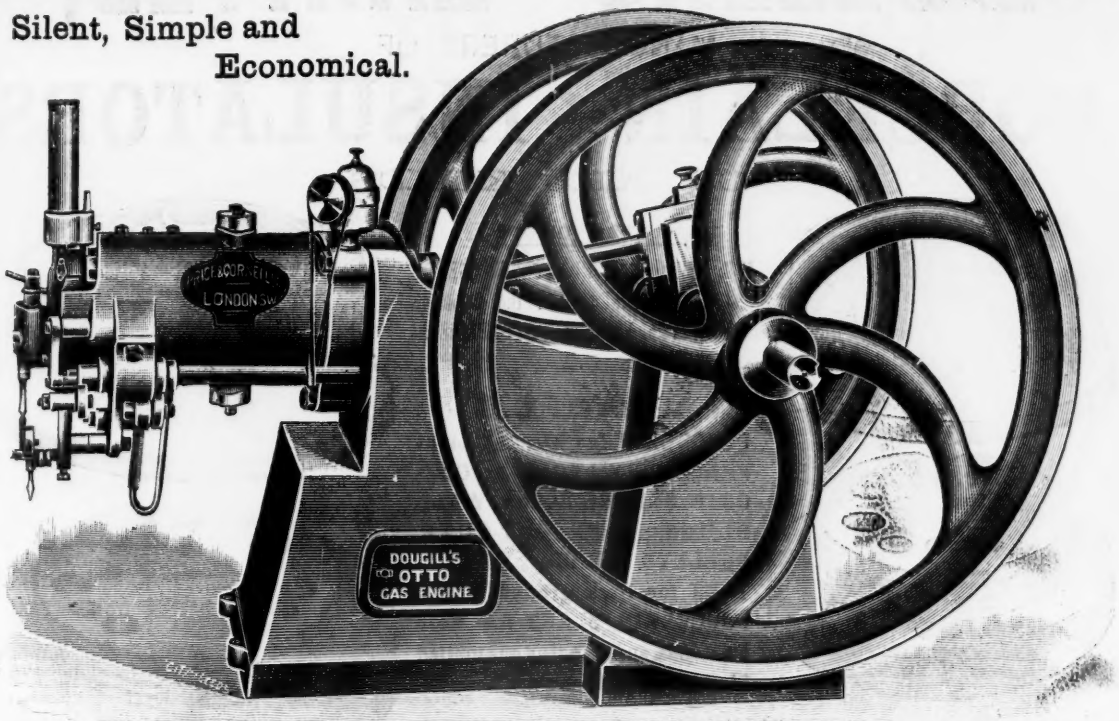

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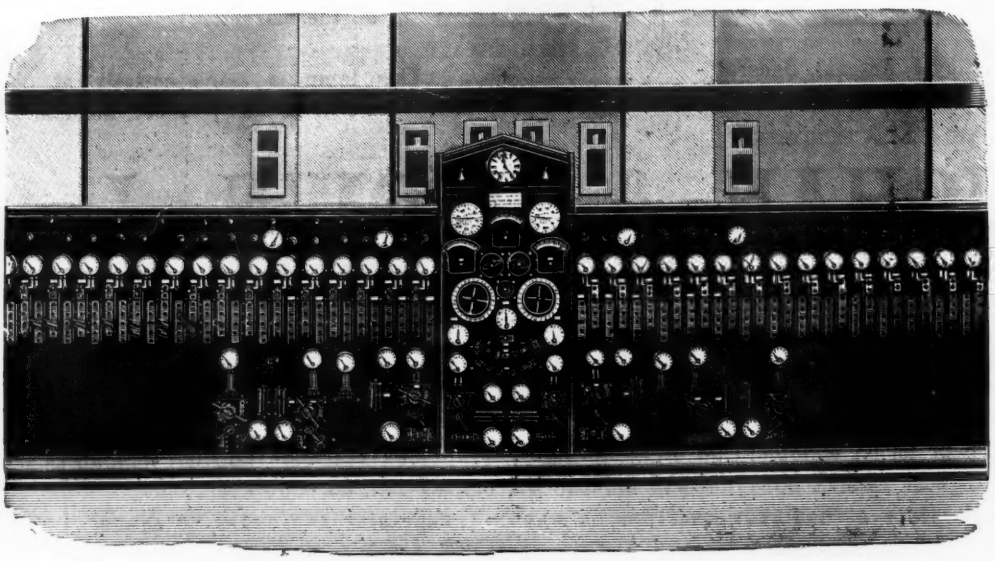

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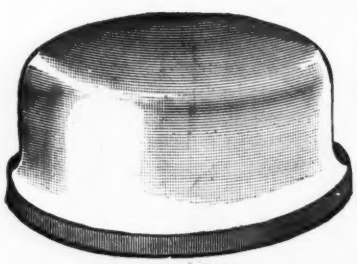

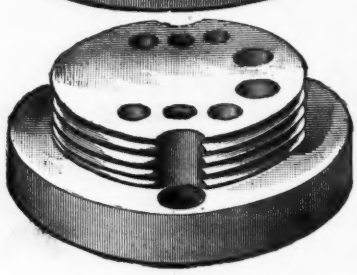

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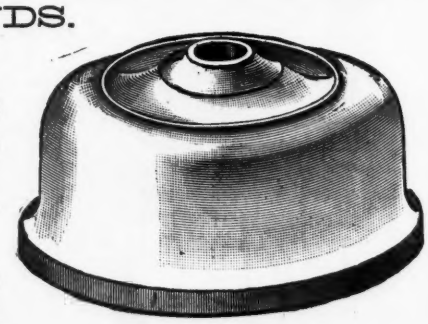

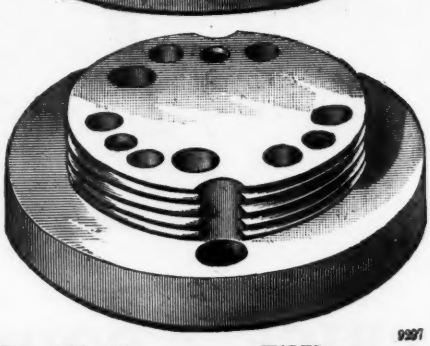

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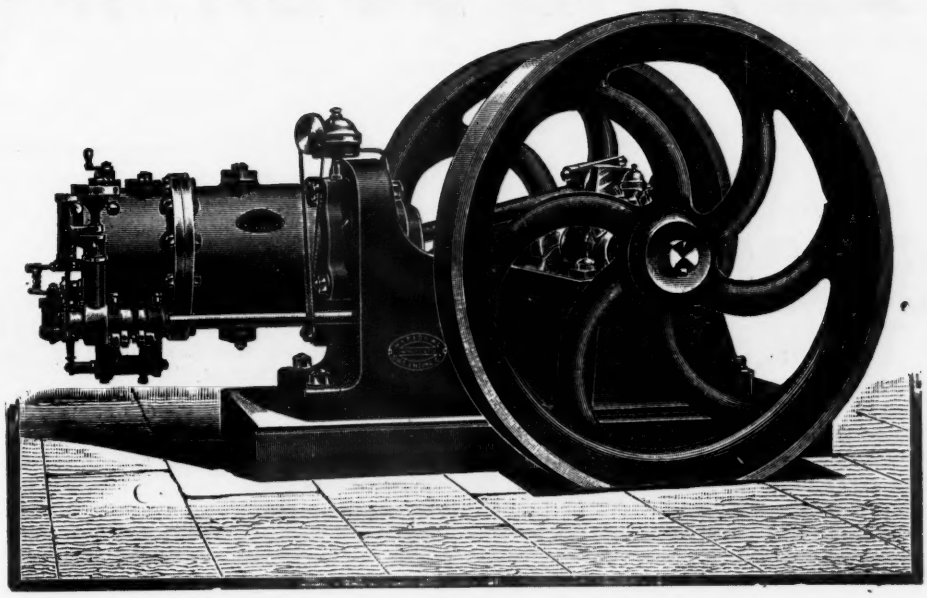

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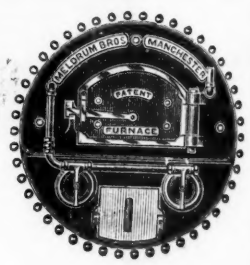

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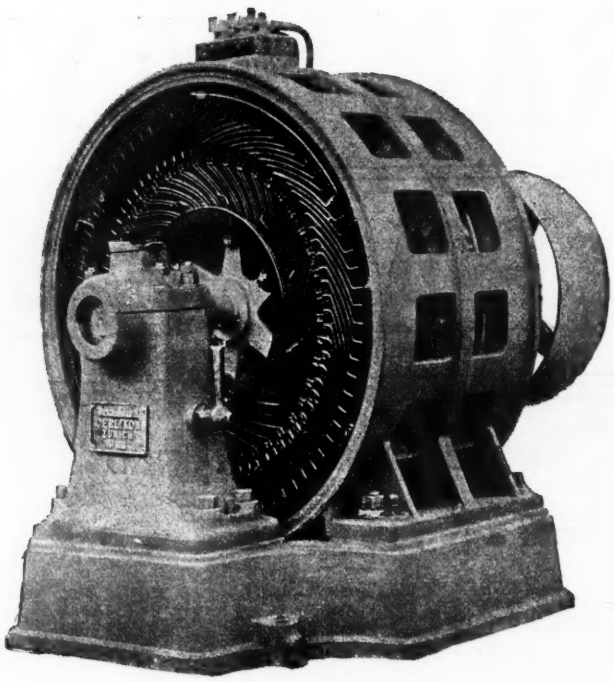

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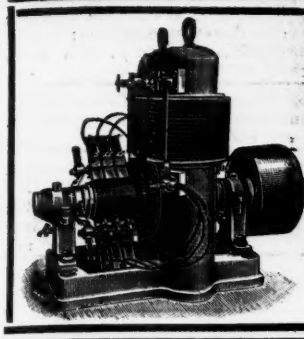

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WANTED, Electrician (junior), for Telephone Work.—Address by letter in first instance, "SUPERINTENDENT," 3, St. Andrew Street, Holborn Circus. 1437

WANTED, Smart Engineer to manage electrical department; must be accustomed to estimating and specifying for both arc and incandescent lighting. State salary required, and send references.—1,453, ELECTRICAL REVIEW, 22, Paternoster Row, London. 1453

SITUATIONS WANTED.

Where Advertisements are to be answered to a given number, letter, or nom *de plume* at the ELECTRICAL REVIEW Office, applications for names and addresses of the Advertisers will be entirely disregarded.

ADVERTISING.—The Advertising Manager of the Edison and Swan Company from February, 1893, to July 22nd, 1897, having left that company is desirous of obtaining a fresh engagement. He has a thorough knowledge of everything appertaining to advertising at home and abroad, experience gained by actual residence in the principal commercial capitals of Great Britain, Canada, U.S.A., the Cape, and Australia. Moderate salary. Highest references.—Please address, Mr. DAVID SCARR, Romford, Essex. 1405

A.I.E.E., six years' mechanical and electrical experience, draughtsman, speaks French, desires engagement.—"C.P.," 17, Nevern Square, S.W. 1461

AS Engine Driver, Stoker, or in charge of hydraulic machinery; many years' experience.—References permitted to Editors REVIEW. 1,396, ELECTRICAL REVIEW, 22, Paternoster Row, London. 396

AS ENGINEER in charge of private installation, gas or oil engine, understands accumulators, pumps, &c. Eight years' experience; good references; been on estate.—"DYNAMO," 89, Western Road, Wood Green, N. 1456

[*Continued on next page.*]

ASSISTANT WIREMAN requires situation, used to installation work; 2 years' experience.—"A. J. C.," 16, Radnor Street, Bath Street, City Road, E.C. 1466

DRAUGHTSMAN and Assistant Engineer, with thorough knowledge of electrical contractor's office routine, used to superintend work, will be shortly disengaged.—Address, 1,456, ELECTRICAL REVIEW, 22, Paternoster Row, London. 1456

ELECTRICAL ENGINEER, 9 years' experience, wishes engagement, home or abroad; has had charge of power plant. Speaks Spanish.—Address "W. L. K.," Mrs. RITCHIE, 110, Hill Street, Glasgow, W. 1435

ELECTRICAL ENGINEER experienced in managing and carrying out lighting, power, and bell work, desires appointment as Manager. Excellent references and testimonials. Age 26.—Address 1,459, ELECTRICAL REVIEW, 22, Paternoster Row, London. 1459

ELECTRICIAN, 7 years' experience, charge of plant, arc lamps, wiring, telephones, accumulators, good references, own repairs.—1,414, ELECTRICAL REVIEW, 22, Paternoster Row, London. 1414

ELECTRICIAN, 23, requires charge of plant (high or low tension) steam or gas engines, accumulators, own repairs and wiring.—W. S. WILSON, Eve Road, Isleworth, Middlesex. 1389

ELECTRICIAN requires charge of plant or wiring, gas engines, dynamos, accumulators, bells, telephones, &c., references.—"E. M.," 175, Hammersmith Road, W. 1388

MAN, 12 years' experience taking charge steam engines, boilers, dynamos, accumulators. Good references, country installation preferred; all repairs.—"G. L.," 43, Amberley Road, Paddington. 1434

PRACTICAL Electrical and Mechanical Engineer, good business man, able manager of men, requires appointment as works manager, or to take full charge of a branch; references are unquestionable.—Address 1,386, ELECTRICAL REVIEW, 22, Paternoster Row, London. 1386

TO CONTRACTING AND CONSULTING ENGINEERS.—A.I.E.E., experienced, desires re-engagement; has served apprenticeship and over 4 years' commercial experience.—1,379, ELECTRICAL REVIEW, 22, Paternoster Row, London, E.C. 1379

WANTED.—Situation as Armature Winder, three years' experience.—FOX, 74, Humberstone Gate, Leicester. 1395

YOUNG Electrical Engineer, well educated, seeks post as Assistant in electrical engineer's office, or would manage branch business and superintend installation work, &c. Five years' practical and theoretical experience at home and abroad. Central station experience; good testimonials.—1,394, ELECTRICAL REVIEW, 22, Paternoster Row, London. 1394

YOUNG GIRL wishes employment, thoroughly understanding electric bell, portable and bobbin winding.—1,452, ELECTRICAL REVIEW, 22, Paternoster Row, London. 1452

ARTICLES FOR SALE AND WANTED, PARTNERSHIPS, &c.

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ACCUMULATORS (old), Copper Cable, Scrap Metal, Metal Dust, and Metal Refuse of any kind bought for cash.—Write A. BROWN, 77, Lansdown Road, Dalston, London. 1368

ACCUMULATOR RECHARGING.—Peto & Radford, Ltd., having increased their storage battery plant, are now prepared to make additional contracts for recharging accumulators of all sizes. Power available night and day. Telephone No. 6,994.—PETO & RADFORD, LTD., 57B, Hatton Garden, London, E.C. s480

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AGENCY.—Wanted reliable firm to take up agency for dynamos, motors, arc lamps, self-starting apparatus for electric cranes and hoists. Highest recommendations given. Principal in London from the 21st to 25th. Write only for appointment.—A. J. H. & Co., 217, Camberwell New Road, London. 1442

ADVERTISER, in touch with central stations, vestrys, electrical engineers, wiring contractors, architects, builders, &c., is desirous of negotiating for an Agency, or as Representative to a leading manufacturing firm.—Address "F. H.," 82, Brompton Road, London, S.W. 1465

CRYPTO MOTOR ¼-H.P., speed 2,500, 100 volts, new; sell cheap; current changed to 200 volts. Seen working in London.—Write "X. P.," Willing's Advertisement Offices, 162, Piccadilly, W. 1454

ELECTRICAL REVIEW, July, '87, to December, '88 (3 vols.), bound; January, '89, to October, '90, unbound. About 60 odd electrical papers. *Journal Inst. Elec. Eng.*, '91, '92, '93, '94, '95, '96, unbound, complete. Offers.—"O. E. W.," Fenwick's Library, Brighton. 1441

FOR SALE.—Griffin Gas Engine, 5½ B.H.P., slide ignition; only worked nine months; in first-class condition; may be seen running any time at our works.—ERNEST F. MOY, LTD., Greenland Place, Camden Town, N.W. 1444

FOR SALE.—New Crompton 16-inch Projector, Chance mirror, high base, hand and automatic feed. Perfect condition.—CHRISTIAN & PHIPPS, Engineers, Hampton Wick. 1431

OFFERS WANTED.—Cloth and leather bound volumes. *Engineer*, 1866—67; *Engineering*, 1882—83—84—85; *Mechanical World*, 1882—83—84;—*Electrical Review*, 1883—84—85; *Electrician*, 1882—83—84—85. DIXON, Imperial Buildings, Newcastle. 1369

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PARSON'S Turbo-Dynamo, 100 volts, 80 amperes, shunt-wound, 80 lbs. steam pressure, complete with mechanical and electric governor and lubricating arrangements. For sale at a reduction, being replaced by a larger plant.—For further particulars apply to LAING, WHARTON & DOWN, LTD., 82a, New Bond St., W. 1445

TO Electrical Engineers and others.—For Sale, at a low valuation, an Electric Launch Business with a good connection, capable of considerable development. Capital required, £5,000.—"K.," care of J. Barker, 2, Castle Court, Birchin Lane, E.C. 1439

WANTED, Good Secondhand Dynamo by Parker or Electric Construction Corporation, Shunt-wound, to give 20 amperes, 65 volts.—Write full particulars as to where it can be seen at work, and lowest price, also number of the machine, Messrs. DRAKE & GORHAM, 66, Victoria Street, Westminster, S.W. 1457

WANTED ½-H.P. Motor, Shunt-wound, 200 volts.—Write particulars, "X. P.," Willing's Advertisement Offices, 162, Piccadilly, W. 1455

WANTED, Electric Lamp Tops and Scrap Platinum.—EDEY AND Co., 256, Ferndale Road, Brixton. s1006

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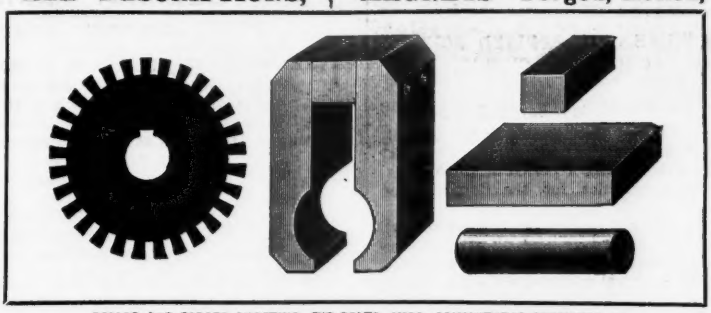

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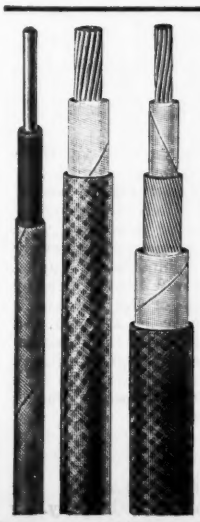

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THE SESSION COMMENCES ON OCTOBER 14th.

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GEOLOGY—Prof. John Young, M.D.
CHEMISTRY—Prof. John Ferguson, M.A., LL.D.
MATHEMATICS—Prof. William Jack, M.A., LL.D.
ENGINEERING—Prof. Archibald Barr, D.Sc., M.Inst.C.E.
NAVAL ARCHITECTURE AND MARINE ENGINEERING—Prof. J. Harvard Biles, M.I.N.A.

Prospectuses of the Courses, with regulations for the degrees of B.Sc. and D.Sc. in Engineering Science, and a list of Bursaries and Scholarships open to Science Students, can be had from the ASSISTANT CLERK. 1447

Official Notices.

CEYLON.

INSTRUCTOR IN ELECTRICAL ENGINEERING AND TELEGRAPHY FOR THE TECHNICAL COLLEGE.

A GENTLEMAN is required to take charge, under the Superintendent of the College, of the Department of Electrical Engineering and Telegraphy (including Telephony). He will be required to teach classes in these subjects, and he will have an assistant. The principal work of his department will be training telegraph and telephone operators for the Government Postal and Railway Departments.

Engagement in the first instance for three years.
Salary, Rs. 4,200 per annum (the present rate of exchange is about 1s. 3d.)

Qualifications.

1. Candidates must have passed creditably a two years' course at a technical college in mechanical and electrical engineering and chemistry.
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3. Must have a practical knowledge of telegraphy and telephony.
4. Must have been teaching for not less than one year some of the subjects comprised in a college course of mechanical or electrical or telegraphic engineering.
5. Age must be from 25 to 30 years.

Free first class passages for himself and family (if any) not exceeding five in all, out and home again on satisfactory termination of engagement.

Applications, stating age and experience, and accompanied by copies of testimonials (not originals), with the names and addresses of references of whom enquiry may be made, will be received by the CROWN AGENTS FOR THE COLONIES, Downing Street, London, S.W., up to September 10th, 1897.

The Crown Agents possess no further particulars respecting this appointment, and cannot therefore undertake to answer enquiries. 1446

Official Notices.

BELFAST HARBOUR.

ELECTRIC LIGHTING.

THE BELFAST HARBOUR COMMISSIONERS are prepared to receive tenders for the supply of the undernoted plant, or of portions thereof (which must be the very best of their respective kinds), in connection with the Extension of the Electric Lighting of the Quays at Belfast Harbour, viz.:—

2 Dynamos.
1 Switchboard.
100 Arc Lamps.
100 Tubular Masts.
100 Isolating Switches.
Mains and Junction Boxes.

Delivery is to be made free into the Harbour Commissioners' Store, which is in the immediate vicinity of the Donegall Quay.

Copies of Outline Specification, Form of Tender, and any further information required, may be obtained from the Harbour Engineer, Mr. G. F. L. GILES, to whose entire satisfaction the plant must be supplied.

Sealed Tenders to be addressed to the SECRETARY to the Belfast Harbour Commissioners, endorsed "Tender for Electric Lighting Plant," and sent in on or before MONDAY, AUGUST 23rd, 1897.

The Commissioners do not bind themselves to accept the lowest or any tender.

W. A. CURRIE,
Secretary.

Harbour Office, Belfast,
August 7th, 1897. 1407

URBAN DISTRICT OF BARKING TOWN

ELECTRIC LIGHTING.

THE BARKING TOWN URBAN DISTRICT COUNCIL are prepared to receive tenders for the supply and erection of the following plant:—

Section A.—Generating Plant, Boilers and Fittings, Economiser, Feed Pump, Injector, &c.; Steam Dynamos, Condensors, Oil Filter, Fittings, &c.; Steam Exhaust, Feed, Blow-off, and Sundry Pipes; Valves, Water-tank, &c.
Section B.—Storage Batteries.
Section C.—Switchboard and all connections.
Section D.—Overhead Travelling Crane.
Section E.—Conduits and Mains for Private Supply.
Section F.—Mains for Public Lighting, and Adaptation of existing lamps.
Section G.—Arc Lamps and Posts.

Tenderers are at liberty to tender for any section or sections, or for the whole of the sections, but not for part of a section. Successful tenderers will be required to enter into a contract to pay the Trades' Union Rate of Wages, and to observe the Trades Union hours of labour.

The Ground Plan of Plant, Diagram of Switchboard, Plan of Streets, &c., and Specifications, with forms of tender, may be obtained at the offices of Mr. W. C. C. Hawtayne, the Consulting Engineer to the Urban District Council, Mansion House Chambers, 20, Bucklersbury, E.C., on and after AUGUST 21st, 1897, on payment of £2 2s. 0d., which sum will be returned on receipt of a *bonâ fide* tender. Tenders, sealed and marked "Tender for Electric Lighting," must be addressed to the Chairman of the Urban District Council, at the Council Offices, Barking, and be delivered on or before 12 o'clock noon on SEPTEMBER 21st, 1897.

The Council do not bind themselves to accept the lowest or any tender.

(Signed)
EDWIN H. LISTER,
Clerk to the Council.

Public Offices, Barking. 1488

In the High Court of Justice. [1897, B 063.]
Chancery Division.
Mr. Justice Stirling.

In the matter of the Brush Electrical Engineering Company, Limited and Reduced,

AND

In the matter of the Companies' Act, 1867,

AND

In the matter of the Companies' Act, 1877.

NOTICE IS HEREBY GIVEN that the Order of the High Court of Justice (Chancery Division) dated August 7th, 1897, confirming the reduction of the capital of the above-named company, from £750,000 to £660,000, and the Minute (approved by the Court) showing with respect to the capital of the company, as altered, the several particulars required by the above statutes were registered by the Registrar of Joint Stock Companies on August 18th, 1897, and, further, take notice that the said Minute is in the words and figures following:—"The capital of the company is £660,000, divided into 150,000 Preference Shares of £2 each, and 180,000 Ordinary Shares of £2 each. At the time of the Registration of this Minute 90,000 Preference Shares and 90,000 Ordinary Shares have been issued, and have been or are deemed to have been paid up in full, and the remaining 60,000 Preference Shares and 90,000 Ordinary Shares still remain unissued."

Dated the 18th day of August 1897.

RENSHAW, KEKEWICH & SMITH,
Of 2, Suffolk Lane, in the City of London,
Solicitors for the Company. 1469

Official Notices.—*Continued.*

COUNTY BOROUGH OF SUNDERLAND.

ELECTRIC LIGHTING.

TO ENGINE BUILDERS AND OTHERS.

THE CORPORATION OF SUNDERLAND are prepared to receive tenders for one Steam Feed Pump.

Specifications and forms of tender can be obtained from Mr. JOHN F. C. SNELL, Borough Electrical Engineer, Dunning Street, at his office on payment of a deposit of £1 1s. (one guinea), which will be returned on receipt of a *bonâ fide* tender.

The persons or firms whose tenders are accepted will be expected to pay the rate of wages to workmen engaged in carrying out the work which is payable by the particular trade affected by the contract in the district where the work is executed.

Sealed tenders addressed to the Chairman of the Highways Committee, Town Hall, Sunderland, must be sent to my office on or before Friday, the 27th inst., and not later than twelve o'clock noon on that day.

Tenders to be endorsed "Tender for Feed Pump."

The Corporation do not bind themselves to accept the lowest or any tender.

By order,

FRAS. M. BOWEY,
Town Clerk.

Town Hall, Sunderland,
August 17th, 1897.

BOROUGH OF DARWEN.

ELECTRICAL ENGINEER.

THE CORPORATION OF DARWEN are prepared to receive applications for the post of Borough Electrical Engineer. The person appointed will be required to devote the whole of his time to the office.

The Corporation have recently received Parliamentary powers to supply electricity within the Borough, and are about to give effect to the Board of Trade Provisional Order; applicants must, therefore, have had practical experience in designing and carrying out electrical installations.

Salary £200 per annum. Applications, stating age and experience, accompanied by not more than three copies of recent testimonials, to be sent to me, marked "Electrical Engineer," on or before SEPTEMBER 6th next.

No canvassing allowed.

By Order,

CHAS. COST KER, *Town Clerk.*

Town Clerk's Office,
Darwen, *August 18th*, 1897. 1461

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BATTERY JARS,

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By EDWARD TREVERT.

This work explains in simple language the theory and practical application of electricity up to date, and will be found invaluable to everybody who is interested in this mysterious force.

CONTENTS:—What is Electricity? What is Magnetism? Electrical Units; Frictional Electricity; Thermo, Pyro, and Atmospheric Electricity; Magnets; Telegraph, Telephone, and Electric Bell; Electric Batteries; Dynamos and Electric Motors; Electric Lamps; Induction Coils or Transformers; Electroplating: Electric Railway; Electric Welding; Index.

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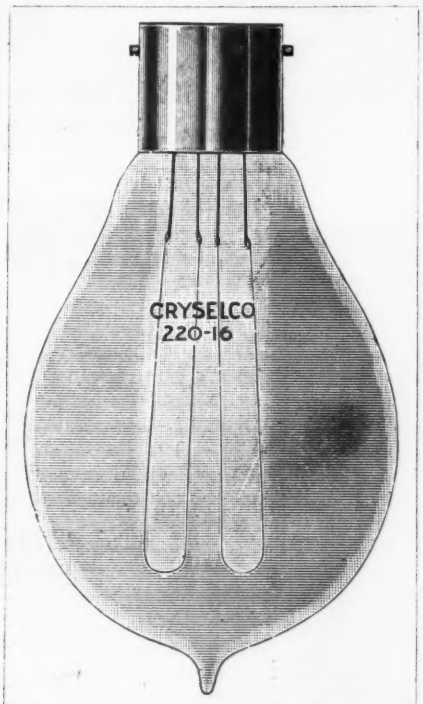

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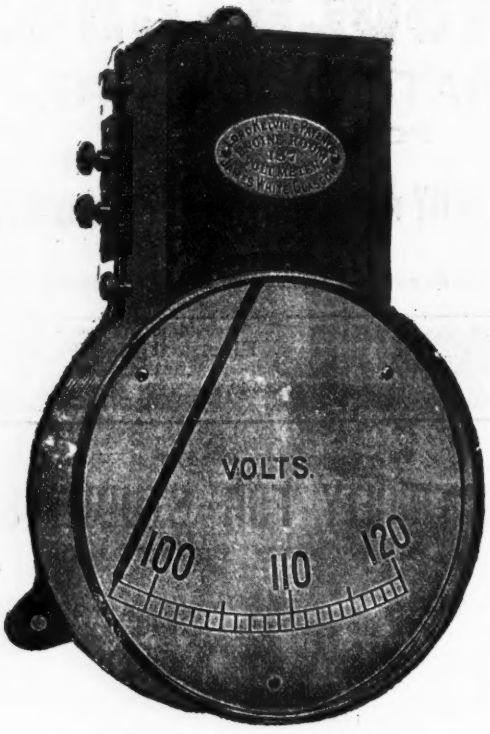

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PORTABLE TESTING SETS,
&c., &c., &c.

Write for New Price Sheets to—

JAMES WHITE,

18, CAMBRIDGE STREET,

GLASGOW. 9943

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Price Lists and Terms on Application. a337

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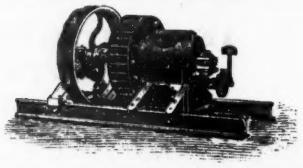

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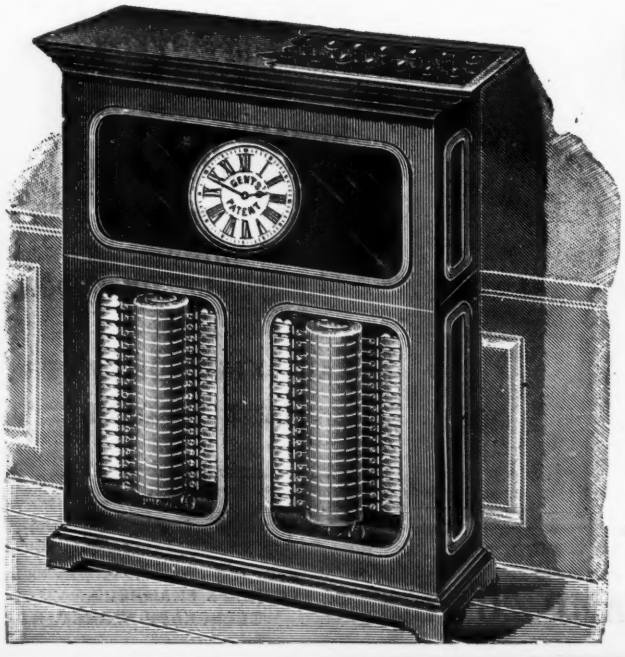

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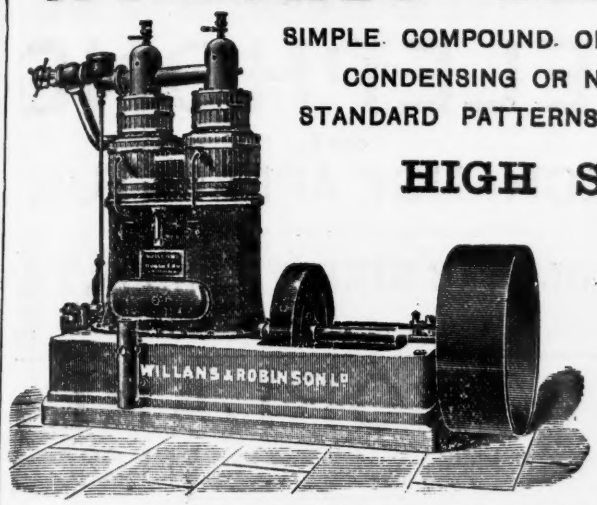

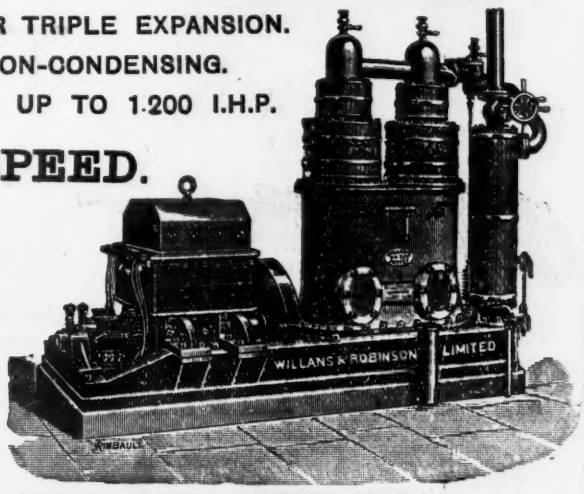

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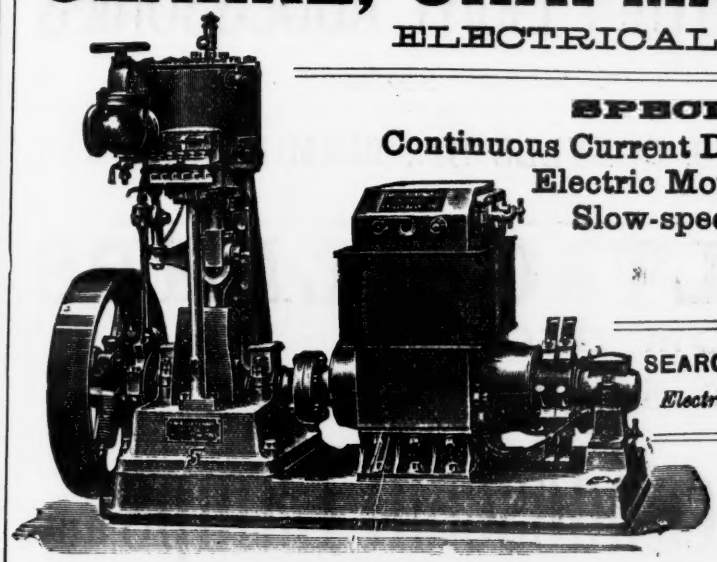

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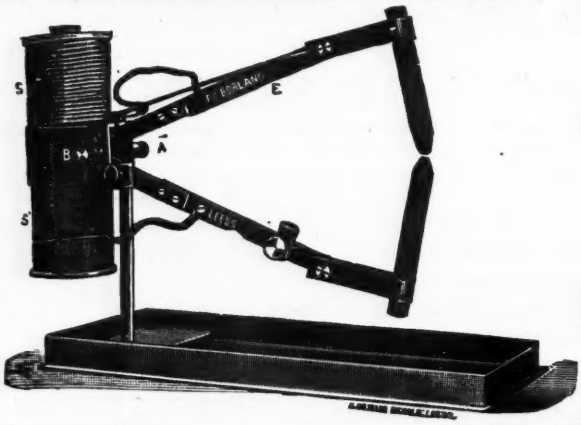

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1135

Port Elizabeth.—September 21st. The Town Council invite tenders for lighting the streets and municipal buildings of Port Elizabeth by electricity in consideration of the grant of a concession for the exclusive right of supplying electric current through the streets and roads of the town to private houses, stores, &c., for terms of 5, 15, 20, 25 or 30 years respectively.

Russia.—November 1st. The Municipal Authorities of Novorossisk, South Russia, are inviting tenders for the concession for the construction and working of an electric tramway and for the electric lighting of the town.

Sofia.—September 22nd. The Secretary of State for Foreign Affairs has received a despatch from the Acting British Consul-General at Sofia, stating that the municipality of that town invite tenders for—(1) The supply of electric current to light the streets as well as public and private buildings in the town and the supply of electric power; and (2) The construction and working of electric tramways in the town and suburbs. Tenders will be received at the offices of the municipality of Sofia. Such further particulars as have been received may be seen at the Commercial Department of the Foreign Office any day between the hours of 11 a.m. and 6 p.m.

Spain.—The Municipal Authorities of Pedralva (Valencia province) are at present inviting tenders for the concession for the electric lighting of the town during a period of ten years. Tenders to be sent to El Secretario del Ayuntamiento de Pedralva (Valencia.)

Spain.—The Municipal Authorities of Villanueva de la Serena (province of Badajoz) are at present inviting tenders for the concession for the electric lighting of the public streets of the town during a period of five years. Tenders to El Secretario del Ayuntamiento de Villanueva de la Serena (Badajoz).

Sunderland. — August 27th. The Corporation of Sunderland are prepared to receive tenders for one steam feed pump. Particulars from our "Official Notices."

Switzerland. — September 25th. Tenders are being invited by the Municipal Authorities of Lausanne for the concession for the establishment and working of a central electricity supply station in the town. Tenders to be sent to, and particulars may be obtained from, Le Conseil Municipal de Lausanne.

CLOSED.

Sunderland.—Mr. John Spencer, of Wednesbury, has obtained the contract for combined arc lamp and trolley poles, and Messrs. Crompton & Co. for arc lamps and accessories.

ELECTRICAL CABS.

The London Electrical Cab Company was formed nine months ago to construct hackney vehicles propelled by electricity to ply for hire in the streets of London. At first sight it might appear that the use of accumulators in connection with these vehicles would prove no more successful than the use of accumulators in the propelling of tramcars, which, up to the present date, can hardly be described as commercially successful. There is, however, a great difference in the use of accumulators on these two types of vehicles.

Owing to the small space available on an electric tramcar for the storage of the cells, the proportional weight of the cells to the total weight of the vehicle is comparatively small, say, as for example, in the case of the accumulator cars run by the Birmingham Central Tramway Company; the weight of the accumulators is 2½ tons out of a total weight of about 13 tons, including passengers.

In the case of an electrical cab, such as those now put into service by the London Electrical Cab Company, the accumulators weigh upwards of 14 cwts. out of a total weight, including passengers, of, say, 30 cwts.

Whilst the cells on an electrical tramcar running under the above conditions are being almost continuously discharged at a higher rate than that normal for the cells, and with a consequent rapid deterioration of the cells, the cells on the electrical cabs are being usually discharged under the normal rate of discharge, and with the arrangements adopted, even in ascending moderate inclines, the normal discharge rate of the cells is said not to be exceeded, and it is only when ascending severe gradients such as those leading into Waterloo Station that the normal discharge rate of the cells is exceeded, and then only by a comparatively small amount.

Early experiments made by the company to determine the energy required to propel the road vehicle on solid rubber tyres, disclosed the fact that the tractive effort on wooden pavements barely exceeds that of a tramcar running on rails, and even on an ordinary macadamised road the energy taken is not much greater. When, however, the thick mud such as that met with only in the country is encountered, the tractive effort is very considerably increased; and this company, therefore, whilst maintaining that it is perfectly practicable to run electrical vehicles in the streets of London, or other well paved and comparatively level towns, with commercial success, do not suggest that the same holds good of vehicles to be used on country roads.

The battery used on each of the vehicles consists of a set of 40 E.P.S. traction type cells, having a capacity of 170 ampere hours when discharged at a rate of 30 amperes.

These cells are all mounted in one tray, which is slung under the bottom of the cab by four suspension links supported by springs under compression, and the ordinary carriage springs again separate the cells from the vibration to which the carriage wheels are exposed.

It being considered that one of the sources of expenditure in the maintenance of traction cells is the amount of pulling about they are usually subjected to in taking them in and out of the vehicles, the cabs have been designed so as to entirely prevent any such damage occurring in their case.

The cabs are placed over an hydraulic table, on to which the tray of cells is wheeled on a light skeleton iron trolley. The table is then raised until the tray comes into the position in which it can be attached to the suspending links. The hydraulic table with the trolley is then lowered and the cab left free to propel itself away.

When the cells are to be changed the cab is propelled over the hydraulic table and the reverse operation takes place. The electrical mechanical equipment on each cab consists of a 3 H.P. Johnson-Lundell motor with a double wound armature and double wound fields, with a series parallel controller by which the connections between the windings of the armature and fields are manipulated. The countershaft to which the motor is geared drives the two driving wheels of the cab through endless chains. As the two wheels are driven by one motor it was essential to adopt a differential gear of the "Jack in the box" type to connect the two halves of the countershaft together. This gear has been ingeniously arranged within the gear wheel driven by the motor pinion and forms a very compact arrangement. The chains connecting the counter shaft with the driving wheels are of Hans Renold's latest laminated type, dispensing entirely with the usual sprocket arrangement, and running on the pinion and chain wheel with the same side play as a belt, thus wearing the chain evenly and enabling it to be used with the same efficiency as when new until completely worn out.

The double wound motor and series parallel controller is perhaps the most important arrangement on the cab, ensuring as it does the greatest economy in the consumption of current at whatever speed the cab may be running.

The controller is arranged so as on the first step to connect on two armatures windings and the two field windings of any series with a small starting resistance; this is not a running speed, but is only intended to start the motor into motion. On the second step the windings are still in series, but the resistance cut out; and with this arrangement the cab runs at a speed of about three miles an hour. The third step places the armatures in parallel, but leaves the fields in series, and with this arrangement the cab runs at about 7 miles an hour. The fourth step places the field windings in parallel, and the cab runs nine miles an hour. It will thus be seen that three normal running speeds allow of the full energy of the current being utilised in the motor without any absorption in resistance, and the cab can thus "crawl" using only about the same number of watts per car mile as when running at full speed. In the reverse direction from the top position the series parallel controller on the first step short circuits the motor through the starting resistance thereby gently braking the cab. On the second step backwards the motor is completely short circuited, bringing the cab to a dead stop; and the third step backwards reverses the connections between the armatures and fields, all being in series to enable the cab to be moved at the slowest speed backwards. The whole of these movements are produced by the use of one lever placed at the side of the driver's box. The circuit from the accumulators to the controller and motor passes through an ingenious switch arrangement attached to the foot-brake, which can also be used for bringing the cab to a stop. This switch is arranged to brake the circuit when the foot-brake is applied, and to brake it rapidly, so that there is no injurious arcing at its contacts. It is therefore impossible, in the use of either the electric or the foot brake, for a careless driver to apply the brake whilst the current is still passing through the motor. The foot brake has another advantage in the crowded London streets, for when moving in a block the driver can set his controller handle to slow ahead, and then start and stop the cab time after time as the traffic slowly moves on by simply putting on and taking off his foot brake.

It was originally estimated that two sets of cells would be required to enable the cab to do an ordinary day's work in the streets of London, it being considered that one set would propel it about 35 miles. The economy of the motor and controller arrangements, however, is so considerable, that it is now found the cabs will do at least 50 miles with one set of cells, and the economy in the use of current thus experienced will make the running of the cabs cheaper than was originally expected. The company recognised that when its service becomes considerable, it will require charging stations in several parts of London, and they therefore determine not to generate their own current for charging, but to purchase it as a day load from supply companies. In their first charging station at Juxon Street, Lambeth, the current is received from the London Electric Supply Corporation at 2,400 volts, alternating with a periodicity of 83 per second. To convert this into a continuous current, two alternating motor generators have been provided, each one with an output of 75 kilowatts on the secondary side. These machines consist of a British Thomson-Houston alternator coupled on the same bed-plate to a continuous current generator of the same make. The alternator is run up to speed by the cells which it is afterwards to charge, put in step with the London Electric Supply Company's current, and the continuous

current field then strengthened until the requisite volts pressure is obtained for charging the cells. The transformation from high pressure alternating to low pressure continuous current is thus effected without the use of any intermediate transformers with an efficiency of about 86 per cent. The Shoreditch Vestry have also entered into a contract with the company for the supply of current at its second charging station, which will probably be in the city at the price of 1½d. per unit.

The charging arrangements for the cells are very complete, a battery having been detached from the cab in the manner previously described, is run on rails over the hydraulic lift, by which it is elevated into the charging gallery above. The battery with its trolley is taken on a second trolley along the gallery into its proper charging position, where it is connected up to the two conductors through the low tension supply. One of these conductors passes directly back to the charging switchboard through a regulating resistance and ammeter, the other conductor being attached to a common return. Each battery is therefore separately connected to the charging switchboard, and the charging current regulated by its own regulating resistance switch. The cells on which these switches are mounted are also used for registering the time at which each battery is put on to the charging circuit, and the rate at which it is being charged.

The opening demonstration of the London Electrical Cab Company, Limited, took place yesterday, and the directors were fortunate in securing Mr. W. H. Preece, C.B., F.R.S., to deliver an explanation of the scheme to one of the largest gatherings of electrical men, and others interested in the subject, we have ever met. Mr. Preece was eloquent in his advocacy of the electrically propelled cabs, but it is a pity he dwelt upon the "mechanics" of the horse, for the noble animal, as a "mode of motion," is just the reverse of the picture Mr. Preece gave.

Fifteen cabs were at the service of the visitors, and in one of these we returned to the City under the capital steering of Driver Slaid. These are the only motor carriages which have been approved and licensed for public hire by the Scotland Yard authorities, and the public service commences to-day.

There is no reason to doubt the commercial success of this undertaking, given a reliable accumulator, and this we are assured is forthcoming. We shall deal with the subject again in our next issue, but in the meantime we may congratulate the directors on inaugurating a service of public vehicles which cannot fail, with reliable batteries, to prove a profitable venture to the company and a real boon to the travelling public, who will be charged no more for a nicely-appointed *coupé* than they now pay for an indifferent hansom, and the chances of accidents from restive and runaway horses will, of course, be entirely eliminated.

NOTES.

Courses in Engineering Science.—It will be seen from our "Official Notices" that the Session at the University of Glasgow commences on October 14th.

The Engineering Strike. — On Saturday, Messrs. Crompton & Co. issued the following important circular to the whole of their workmen who are locked out or on strike:—

"Three years ago ours was practically a non-society shop. Mr. Golightly admitted this when, in December, 1894, he called upon us on behalf of the Amalgamated Society of Engineers to ask us whether we could not see our way to allowing their members to enter our employment. We declined to take action in the matter, but the society have contrived to introduce their men, and these have induced others amongst our own old hands to join the society, so that the present dispute with the Amalgamated Society of Engineers has affected some 140 men. The dispute does not lie between us and our workmen. We are quarrelling solely with the officials of the A.S.E., who on May 28th last served a notice on us that we were to discontinue overtime unless we were prepared to concede a 48-hour week without reduction of pay to our workmen. The sending of this notice may or may not have been a mistake on the part of the A.S.E. officials. We fully believed that it was intended for this shop. Whether this was so or not makes now no difference to us, for as we know that the policy of the A.S.E. has always been to attack a few employers at a time, and thus to win concessions from them, and then at a later date force these concessions on to shops which contain any considerable number of their members; and as we believe it is quite impossible for us to grant a 48-hour week, we have joined the Federation of Employers in order that this and other important questions may be fairly fought out. It seemed fair to us that as the whole resources of the A.S.E. of the kingdom were being used to fight the London district of employers on this important question of a 48-hour week, we should avail ourselves of the resources of the employers of the whole kingdom by federating ourselves with them to deal with this matter. As we believed the total number of society men in our works did not exceed 56, we locked out 14 men only; but, from the number of men who struck work in consequence of this, it is evident to us that the tactics of the society have been to get into their ranks as many as possible of those of our workmen whose withdrawal from work would cause the *maximum* amount of trouble to us, and hardship not only to themselves, but to a much larger body of fellow-workmen who are not concerned in the dispute between ourselves and the A.S.E. Our wish has been to keep as clear as possible of all outside interference, and hence to keep clear of the troubles of the trade, but we are firmly convinced that so long as there are members of the A.S.E. in our shops, it will be impossible for us to attain this end. We wish, therefore, to make it quite clear to our workmen that, whatever may be the result of the present dispute between the A.S.E. on the one hand and the Federation of Employers on the other, we, as a Chelmsford firm, will not knowingly keep in our employment now or hereafter any member of the A.S.E. or other trade society. We wish it to be clearly understood that we have no quarrel with our workmen other than those who are members of the A.S.E., which society has declared war upon us in common with other employers of the kingdom. We are fully determined to fill our shops with non-union workmen, and are now taking steps to do this, but have delayed doing so as long as possible, hoping that the non-union workmen who are at present out on strike and those of our old workmen who have been persuaded to join the union, but who we hope will now consent to leave it, would return to their work, in which case they would be welcome; but we take this opportunity of stating that we must fill up the vacancies in our shops rapidly, and that if they do not apply to be taken on again by August 16th, their places will be permanently filled by others, a result which, it is needless to say, we should greatly regret.

Crompton & Co., Limited,

R. E. Crompton, *Managing Director.*

The locked-out men who were in the employ of Messrs. Crompton & Co., at the Arc Works, Chelmsford, have issued to the firm and the public a statement in which they deny the assertion that they asked the firm to employ members of their society. The men say, *inter alia*—

That three years ago their accredited official called upon Mr. Brunton, the works manager, and requested—not that Crompton & Co. should employ their members—but that those who had joined the society of their own free will should be left alone, to follow their employment in peace, without let or hindrance, so long as they (the workmen) performed their work in a satisfactory manner and committed no breach of the printed rules of the firm. He (the official) received a distinct and emphatic promise that this should be done. They have never authorised anyone to send in a notice on their behalf to Crompton & Co. for any interference with the present working hours of the firm. Other engineering firms employing the pick of the workmen in the English engineering industry have picked the same quarrel with their employés as this firm, but none have gone the length to declare their works permanently closed to union men, or denied them the right to combination. It seems fair to them that the firm should be allowed the same right to combine as they claim for themselves for mutual protection, but not to combine to take away the liberty of their workmen to provide for sickness, want of employment, and a pension in old age. They wish, therefore, to say that, whatever may be the result of the quarrel the firm have forced upon them, they will claim a perfect right to belong to any society they please which allows them, as the A.S.E. does, local control of their own affairs.

The officials of the Employers' Federation on Wednesday caused the following communication, which they had received from the firm of Messrs. Thomas Parker & Co., Wolverhampton, to be circulated to the members throughout the United Kingdom:—

With regard to your question with respect to ourselves and the 49 hours, I was impressed at the time of our starting these works (October, 1894) that if we got the men to work promptly and did away with the breakfast half-hour, running the day in two terms, from 8 to 12.30 and from 1.30 to 6, we should not suffer much, and this would give the men an opportunity of indulging in their desire of reducing the number of hours. But there was not at all that satisfaction among the men with regard to the hours that we expected. They would indulge in lunches in the forenoon, and the promptitude was in no way marked over the longer hours, and they did not like working until 6 o'clock in the evening. In the summer of 1896 there was a decision of the union to increase the rate of wages in the district, and we were at once attacked by the union for this additional increase. We suggested that we had made the sacrifice of running our tools less hours, and had given them the advantage of the less hours, but this in no way abated their determination to get the full rate they required in the district, although they did not attack the Great Western Railway Company, who are the largest employers here, until they had forced the smaller masters. Being compelled to pay these extra wages, we decided we could not do it without returning to the 53 hours, which was done at this date (September 1st, 1896). The demands of the union as to overtime, night work, with their notion of curtailing output, and that a man put to a machine should have the conditions and pay of a mechanic, gives our competition with foreign competitors a serious outlook, and management is rendered irksome and difficult.

The New Corps of Electrical Engineer Volunteers.—The *Daily News* last week had the following: "The Secretary for War has approved of the officers who are shortly to be appointed to the new corps of Electrical Engineer Volunteers, going through courses of training this year at Shornmead Fort, in the Thames Defences, and at the Submarine Mining Station in the Isle of Wight. Beside Major J. Hopkinson, a former President of the Institution of Electrical Engineers, who has already been gazetted to the command, and Captain Brady, Royal Engineers, who has been appointed Adjutant, the names of several gentlemen associated practically with electrical science have been submitted to the War Office for commissions; and a large number of men employed in electrical works in the eastern suburbs of the metropolis, as well as members of the Institution of Electrical Engineers, have expressed their willingness to join the ranks of the corps, whose principal duty will be in working electric lights at defended ports where there is a deficiency of trained regulars, and in connection with submarine mining. Actual enrolment of the rank and file for the four companies which it is proposed shall be the first establishment will be deferred probably for a couple of months, as it would be impossible for the men to become efficient for the current year, which ends on the 31st of October. It is proposed that the regimental headquarters shall be in the neighbourhood of Greenwich, to suit the convenience of the many employés of local works from which a large proportion of the recruits are expected.

The Hampstead Lighting Fatality.—At the Bloomsbury County Court, on the 4th inst., before Judge Bacon, the case of White *v.* the Vestry of Hampstead, arising out of electric lighting fatality, came before His Honour for judicial settlement. Mr. Marshall Hall, barrister, instructed by Mr. Freke Palmer, solicitor, appeared for the plaintiff, and Mr. F. J. Frankau, barrister, instructed by Mr. A. P. Johnson, solicitor, the Vestry clerk, appeared for the defendants (the Vestry). The terms of settlement had already been agreed upon, viz., £170 to the widow und child, and £30 costs. The judge was therefore asked to allocate the amount between the widow and child. The judgment by consent was for £170, to be apportioned as follows:—£70 for the widow, and £100 to the child Harry White, the amount to be invested in the Post Office Savings Bank in the name of the Registrar. The counsel for the plaintiff stated in his address to the judge that the Vestry had behaved both handsomely and honourably in the matter.

Supposed Suicide of an Electrical Engineer.—The body of Mr. Harry Glascodine, who was engaged in the Crompton-Howell Electric Works, at Llanelly, was on Saturday afternoon found drowned in the Loughor River, and it is supposed that he committed suicide. The deceased, who was a native of Bath, was engaged in erecting the electrical illuminations at Windsor Castle on the occasion of the Queen's Jubilee.

Third Rail Systems Under Water.—The *Street Railway Journal* says: "We notice that the *Electrical Review*, of London, takes exception to the statement of President Clark, of the New York, New Haven & Hartford Railroad, that cars have been operated for hours over sections of his line when both the third rail and service rails were covered with water. The *Review* evidently thinks that such a thing is impossible and 'a piece of exaggeration that any tyro would detect.' It is true, nevertheless, that such things have happened and can happen, and in fact may be expected to happen under such conditions as are found at Nantasket Beach, for it is a fact demonstrated repeatedly in conduit and third rail work that the resistance of rain-water or even of water which is by no means chemically pure is sufficiently great to prevent a leakage approaching a short circuit on a line with only 500 volts pressure. Those who have tested railway plants with water rheostats can easily understand this, knowing the difficulty of forcing a large volume of current through a body of water, unless the plates are placed quite close together; and we may add, for the benefit of our doubting contemporary, that the recent heavy rains in Connecticut flooded the tracks of the Hartford-Berlin third rail electric road without interfering with operation.

Explosion in Edinburgh.—On Sunday night considerable excitement was occasioned in the West-End of Edinburgh by an explosion of gas in Charlotte Square. The explosion, so says the *North British Daily Mail*, occurred on the north side of the square, almost in front of St. George's Church. Some of the pavement flagstones were heaved up a little, and flames burst forth through the crevices. As far as can be ascertained the explosion was due to an escape of gas from the pipes in one of the houses in Charlotte Square. The gas appeared to have found its way into the electric light mains, becoming ignited in some way by the electricity. It was at first thought that the electric light manholes had sustained some damage, but as they are hermetically sealed they were able to resist the pressure, which, however, forced up the pavement around the manholes. Fortunately, no one was injured, but the inhabitants in the neighbouring houses were greatly alarmed. Occurring at an hour when Princes Street is crowded with pedestrians, the incident was soon mooted about, and a great crowd gathered in Charlotte Square, where a bright blue light was burning at several places from holes in the pavement. The officials at the electric lighting station were speedily apprised of the occurrence, and half a dozen workmen were soon engaged at the manholes. Their operations were followed with great interest by the spectators, but rain commencing to fall shortly after nine o'clock the crowd soon dispersed. In consequence of the operations the electric light was turned off in Charlotte Square.

The Supply of Copper.—The *Financial News* says the visible supply of copper on August 15th shows a small decrease of 401 tons as compared with July 31st. The deliveries between these two dates, according to Messrs. James & Shakespeare's statistics, were 5,665 tons, while the receipts were 5,914 tons, or 249 tons above the quantity taken for consumption. The reduction in the visible supply is due to reduced shipments afloat from Chili and Australia, the quantities now on the sea from those countries being 3,600 tons, as against 4,250 tons on July 31st. The visible supply is now 322 tons less than on July 15th.

Electric Lighting in Passenger Steamships.—The Board of Trade has issued to the official surveyors instructions with regard to the lighting of passenger steamships by electricity. Attention is drawn to the fact that owing to the usual low position occupied by the electric lighting plant in the engine room, it would be rendered useless should water enter the compartment, even to a small extent, through stranding or other cause. To obviate this difficulty the surveyors are requested to "strongly recommend the position of the source of the light be at such a height in the vessel as to prevent, as far as possible, the contingency of the light being extinguished." There can be no doubt, says a contemporary, that the suggestion is an excellent one, for, while in most steamers the lower platform affords the most convenient position for the electric light engines, an advantage of considerable importance is obtained by placing it on an upper one, where, indeed, it is to be found in many modern ships.

The Granting of Provisional Orders.—A scheme has been promulgated among County Councils and other local governing bodies by the Yorkshire West Riding County Council for the proposed transfer to County Councils of the powers of the Board of Trade of granting Provisional Orders for electric lighting undertakings.

Heating Steel Billets by Electricity.—It is said that interesting experiments are being carried on by the Carnegie Steel Company at its Homestead Works in heating steel billets by electricity. Economy in fuel and a saving in time required to heat the billets are claimed. It is also asserted that the billets are heated from the centre to the outer surface, ensuring equal heat throughout the mass. The steel thus treated is reported to be of better quality, from the fact that the exact temperature may be obtained without overheating.

Obituary.—We regret to learn of the death of **Mr. F. V. Andersen**, who was drowned a few days ago off the Shipwash. According to the daily press, the captain of the Danish steamer *Koldinghuss* on arrival at Gorleston reported the loss of a passenger about four miles off the Shipwash. On investigation it was found that the unfortunate passenger was Mr. F. V. Andersen, whose name we need hardly say is well known in electrical circles. The deceased gentleman was in the early days of electrical work connected with the E.P.S. Co., and carried out very important work. He was later associated with Latimer Clark, Muirhead & Co., and during his connection with this company devised what is now known as the ring main system. He was probably the first to devise an automatic cut-out, and many of his devices, notably the charging switch, are among the common appliances of to-day. Mr. Andersen was at one time a frequent contributor to these columns, and though he was of a most retiring disposition, he occasionally took part in the discussions at the Institution of Electrical Engineers. We extend to his relatives and friends our hearty sympathy for the loss—so tragic and sudden—which they have sustained.

The British Association.—A correspondent of the *Times*, telegraphing from Montreal on August 16th, says:—Most of the members of the British Association arrived in Montreal to-day. There was a reception of the members at the M'Gill University, at which about 200 persons were present. The visitors were received by Vice-Principal Johnson, the Governors, and the Fellows, and were conducted in parties over the University, its fine collections, laboratories, &c. Luncheon was served in Molson Hall, and the president of the governors proposed the toast of the Association. Lord Lister responded, and Sir John Evans proposed the toast of the University. The National Anthem was sung, and afterwards the company drove in carriages to Mount Royal, where a reception was held, which was much appreciated by the Association. The weather was superb. The majority of the members leave to-night for Toronto.

The Dangers of Engineering.—Mr. Colquhoun, an assistant in the testing department at the works of Willans and Robinson, Rugby, had a very narrow escape from serious injury on Monday morning. He was sitting down writing at a table, when a shot or bullet was fired through the window in front of him, and must have passed within two inches of his head. Where the bullet came from has not yet been discovered, but about the time the incident occurred the discharge of a firearm was heard in the direction of the railway. The notion that the shot was fired by someone in a passing train is not generally accepted. It seems more probable that it came from the fields beyond the metals, where during the day some men are said to have been rabbiting. The police are making inquiries, but as yet no satisfactory solution has been found. Happily, no damage was done in the department beyond the breaking of the pane of glass.

NEW COMPANIES REGISTERED.

Thomas G. Poole, Limited (53,736).—Registered August 15th with a capital of £3,000 in £1 shares to adopt an agreement with T. G. Poole, and to carry on the business of electricians, engineers, suppliers of electricity, and electrical apparatus manufacturers. The subscribers (with one share each) are:—F. Thornton, 48, Westover Road, S.W., electrical engineer; T. G. Poole, 11, Queen Victoria Street, E.C., electrical engineer; F. E. Howard, 91, Bennerley Road, Clapham Junction, electrical engineer; L. Last, 30, Westdown Road, Stratford, E., clerk; S. T. Slee, 159, Portman Street, Walworth, S.E., clerk; A. W. Richards, 1, Powerscroft Road, Clapton, electrician; H. Noyce, 662, Old Kent Road, S.E., clerk. The number of directors is not to be less than two nor more than five; the subscribers are to appoint the first; remuneration as fixed by the company. Registered by T. Durant, 5, Guildhall Chambers, E.C.

Electric Fur Machining Company, Limited (53,742).—Registered August 14th, with capital £3,600 in £1 shares, to carry on the business of electric fur machinists, engineers and manufacturers, workers and dealers of and in skins and furs. The subscribers (with one share each) are:—C. E. Cluer, 20, Highbury Park, N., clerk; J. Rickinson, 25, Hamilton Road, Highbury, N., clerk; F. H. Paulig, 90, Crondall Road, New North Road, N., stationer; W. Wreetham, 90, Crondall Road, New North Road, N., clerk; G. Smith, 5, Pownall Road, Dalston, warehouseman; J. W. Sydney, 8, Coleraine Road, Hornsey, traveller; G. H. Hiscocks, 35, Artesian Road, Bayswater, law student. The number of directors is not to be less than three nor more than seven; the first are G. Keukeler, E. Leveque, and C. Paulig; qualification, £25. Registered by Holder & Wood, 40, Cheapside, E.C.

OFFICIAL RETURNS OF ELECTRICAL COMPANIES.

Laing, Wharton & Down, Limited (49,645).—This company's annual return was filed on June 10th. The capital is £30,000 in £1 shares (of which 6,000 are preference). 12,000 ordinary and 3,000 preference have been taken up, and 11,933 of the former and all the latter are considered as paid. £7 has been called and paid on the rest.

Larne Electric Light Works Limited (46,962).—This company's annual return was filed on June 11th. The capital is £4,000 in £1 shares (of which 3,500 are ordinary and 500 preference). All the ordinary have been considered as paid; 105 preference have been taken up, and paid for in full.

CITY NOTES.

Bristol Tramways Company, Limited.

The half-yearly meeting of this company was held last Thursday at the Grand Hotel, Bristol. Mr. C. H. Low presided in the absence, through ill-health, of the chairman of the directors, Mr. William Butler.

Among other remarks, the Chairman said the balance of profit was £13,865 against £11,646. The receipts of both departments showed an increase of £5,352, whilst the number of passengers carried on the tramways during the past six months was the record figure of 9,497,693. The report explained that the company's Bill had received the Royal Assent, and that they were pushing forward vigorously with the extention to Staple Hill. They intended to open the line in two sections; the first one, to Fishponds, would be ready for opening, he hoped, not later than the first week in September, and the complete extension to Staple Hill ought to be inaugurated about a month later from that time. They regarded the future of the line, worked as it would be economically from the St. George power station, with considerable confidence, and believed that it would fully bear its share in the profitable results of their working. They had informed the shareholders from time to time of their progress in the application to the Light Railway Commissioners for the line to Hanham. It was satisfactory to find that the whole of the local authorities were in perfect accord with the company in desiring that this work should be carried out under the provisions of the Light Railway Act, but they would have seen that the Corporation of Bristol were seeking to be heard in opposition, and should they be successful in materially altering the company's order, it would have to be withdrawn, and St. George and Hanham would reap the first fruits of their amalgamation with the city. He need hardly say that, backed as the company were by the unanimous approval of the people of the district, the directors would be able to present such a strong case to the Railway Commissioners that he could not believe the opposition of the Corporation of Bristol would much avail. On the general question of the extension of the use of electricity on the city lines there was little to be added to the various speeches of their chairman on the recent occasions when they had the pleasure of meeting the shareholders. He could only repeat that the citizens of Bristol were fully aware that the company were anxious to be in the van of progress, and to give the public the superior advantages of working the whole of the tramways by electric traction. The delay which had taken place up to the present was not of their seeking, but was wholly due to the

Corporation of Bristol in attempting to force them to become customers of their electric light department, whilst the company were willing and able to provide their own current and do their own business, and so be able to render a good account of themselves in the public service. They had never wavered in the strong views expressed to the shareholders on former occasions of the futility of attempting to carry out such a dual arrangement as was suggested, and he could only say that every month which passed brought to them practical illustrations showing that they had adopted the right course, and one by which they intended strictly to abide. He moved:—"That the directors' report and statement of accounts for the half-year ended June 30th, 1897, be received and adopted, and that a dividend at the rate of 6 per cent. per annum (free of income-tax) be paid on the amounts paid up on the shares and entitled to rank for dividend during the half-year."

The resolution was adopted.

North Staffordshire Tramways Company, Limited.

A meeting of this company was held on Wednesday at the Guildhall Tavern, under the presidency of Mr. A. J. Carruthers-Wain.

In moving the adoption of the report and accounts to June 30 last, the Chairman remarked that the latter exhibited a small increase in the revenue, much smaller than they should desire; but this was due to the general upsetting of business by the American tariff, and to the expectation of better things to come by waiting. Notwithstanding this, the traffic had fairly held its own. The traffic receipts had increased by £269, and per mile run were 13·81d., as compared with 13·92d. in the corresponding period of 1896. The number of passengers carried showed an increase of 79,607, as compared with those conveyed in the first half of 1896, and the average fare was 1·27d. as compared with 1·32d. in 1896. The mileage run had increased by 6,126 miles. The total expenditure was £420 more than in the corresponding period in 1896, and was at the rate of 9·65d. per mile run, as compared with 9·40d. in the same term last year, and was 71 per cent. of the gross receipts. The profit on the half-year's working amounted to £3,327, and after adding thereto the balance of £694, brought forward from the previous half-year, &c., the sum of £3,609 was available for distribution amongst the Proprietors. The interest paid on Debenture Bonds amounted to £849, and the Directors proposed, after providing £446 for interest on the Six per Cent. Preference Shares, to pay a dividend at the rate of 3 per cent. per annum on the ordinary capital, which would absorb £1,025. It redounded, he thought, to the credit of the manager and staff that they had been able to put the whole of their 20 engines into the service on given occasions. The expenses had slightly increased, but that was natural, as engines and lines got older. With regard to the future prospects of the company, he said they had made an agreement with the local authorities for an extension of the time within which they would be able to give them notice to purchase their line, and they had got a renewal of practically 14 years on a condition that they would change their present mode of traction from steam to electric. Some shareholders had blamed them in the past for doing too much, and others too little, and between the two they had tried to steer a moderate course. The electric equipment had practically been supplied, the buildings were in process of erection, and the poles had been placed. During the past half-year a large amount of work had been done in connection with the necessary alterations to the line and its equipment consequent on the substitution of electric for steam traction in accordance with the agreements with the various local authorities, by reason of which substitution the company had obtained a waiver of the power to purchase by the authorities of about 14 years. The relaying of the line had been commenced, and was being proceeded with rapidly, the whole of the electric poles had been erected, the greater part of the span wiring been done, and progress was being made with the erection of the generating station. They had now under consideration an agreement with the Potteries Extension Tramways Company (which had taken over the powers to make the various extensions originally proposed to be made by this company, and had commenced to construct them) for the granting of running powers over this company's line on equitable terms to be agreed, thus bringing all the outlying districts of the Potteries into direct communication with the central towns, and affording cheap and frequent facilities for travel to the adjacent population. This through communication should be of great benefit to this company. Powers for further extensions of their lines had been obtained by the Potteries Company, and these also should be a source of additional profit to this company. There was every opportunity of developing the traffic provided they could give the facilities which they were now endeavouring to afford the public. The more frequent the service on their line was the greater was the encouragement to the public to travel. The requirements of the local authorities had necessitated a large expenditure for renewals and repairs of the permanent way. The directors had endeavoured by all means in their power to carry their heavy traffic as safely as possible, and this policy they would continue, and consequently they proposed to place £1,000 to the depreciation and renewal fund, and carry forward the balance.

The motion was seconded by Mr. Alderman Hammersley, who observed that the future success of the undertaking depended very much on the care which the directors would have to exercise with regard to the question of running powers. He was inclined to think that they had not got all that they ought to have, but the question of running powers would have the further consideration of the board. They must have a *quid pro quo*, and do the best they could for their own independent undertaking. They were a dividend-paying company, and must not go into any rash speculations.

The report and accounts were then adopted, and the dividend confirmed. The usual votes of thanks closed the proceedings.

Cuba Submarine Telegraph Company, Limited.

The fifty-second ordinary general meeting of the Cuba Submarine Telegraph Company was held at the offices, 58, Old Broad Street, E.C., on Wednesday, Mr. Charles W. Parish (chairman) presiding.

The Chairman, in moving the adoption of the report, said that following the usual custom he would first lay before them some comparisons of the results of the last half-year with the corresponding half-year of 1896, and then proceed to deal with more general matters. Their revenue account showed traffic receipts and subsidies £24,013, as against £34,868 in 1896; a falling off of £10,854, due principally to the loss of the French traffic. Their interests on investment during the same period had produced £1,599, against £1,309, or an increase of £290. The expenses had been somewhat less. In the past half-year they came to £7,005, whilst in the corresponding half-year they were £9,425. He should explain, however, that the latter sum included £1,789 for cable repairs, so that there was really a saving of £633. When they came to analyse each item of expenditure there was not any particular one which had caused that saving. It was due to those variations which naturally occurred in so large a business as theirs. The London office expenses were rather more, while the expenses at the station came to £4,625 as compared with £5,175 in 1896. The reduction was generally due to maintenance of lines and an item of travelling expenses, which were of necessity of a varying nature. The actual result of the past half-year's working showed £18,617 to the credit of revenue account; a result with which they were well pleased, for it enabled them to pay their preference dividend, a dividend at the rate of 8 per cent. on the ordinary shares, and to carry £9,000 to reserve account, which brought up the reserve fund to £118,000, which they considered very satisfactory. The new cable which they were going to lay from Santiago to Manzarillo would cost some £25,000, which would be charged to reserve account. Information was given in the last report as to the Haiti and New York cable being laid to deal with the French traffic, and they would have been prepared for the falling off in the receipts. The French company was now engaged in laying the cable from New York to Brest to complete their system, and they understood they would enjoy the large yearly subsidy of 800,000 francs for 30 years from the French Government under certain conditions, and they would also derive further subsidies from islands they served. There had also been some falling off in the Cuba or local business, which had been exceedingly large of late, owing to the disturbed state of the land. He was afraid they would be subjected to still further competition, for on the very day after their report was issued Mr. Hanbury laid before Parliament and obtained its approval of the Halifax and Bermuda Contract to continue the line to Jamaica, with a subsidy of £8,000 and a 3s. rate to London. He mentioned at their meeting in August that the Government had communicated with the West Indian & Panama Co. and their company concerning the cable, and they went so far as to make an offer to lay it on certain conditions which they thought exceedingly reasonable; but when the French line with its large subsidy was laid, the whole position was changed, and they found they could not modify their proposals to the extent proposed by the Government. Should the new cable be laid, they would have two subsided lines coming down to the West Indies—the French company with a subsidy of £32,000, and the Halifax and Bermuda Company with a subsidy of £16,000. What the effect would be upon their traffic it was impossible to say. They could only promise to do their very best to protect the shareholders interests.

Mr. Geo. Keith seconded the motion, which was carried.

The Chairman next proposed the payment of a dividend of 10 per cent. on the preference shares and 8 per cent. on the ordinary, and this was seconded by Mr. R. K. Gray and agreed to.

In moving the re-election of Mr. Keith as director, the Chairman referred to that gentleman's great work for the company, and said it was his intention to go out and see to the laying of the new cable.

Mr. John Hooper seconded the motion, and said the cables laid in Cuba would cost the company little, owing to the care exercised by Mr. Keith.

The motion was carried, and a vote of thanks to the chairman concluded the proceedings.

Brush Electrical Engineering Company, Limited, and Reduced.—Notice is hereby given that the transfer books of the first debenture stock of this company will, in view of interest payable on September 1st, 1897, be closed from August 19th, 1897, to September 1st, 1897, both inclusive.

TRAFFIC RECEIPTS.

The City and South London Railway Company. The receipts for the week ending August 15th, 1897, were £337; week ending August 16th, 1896, £1,110; decrease, £273; total receipts for half-year, 1897, £6,293; corresponding period, 1896, £6,529; decrease, £236.

The Liverpool Overhead Railway Company. The receipts for the week ending August 15th, 1897, amounted to £1,516; corresponding week last year, £1,375; increase, £141.

The Western and Brazilian Telegraph Company, Limited. The receipts for the week ending August 13th, 1897, after deducting 17 per cent. of the gross receipts payable to the London Platino-Brazilian Telegraph Company, Limited, were £2,539.

SHARE LIST OF ELECTRICAL COMPANIES.

TELEGRAPH AND TELEPHONE COMPANIES.

Present issue.	NAME.	Stock or Share. ‡	Dividends for the last three years. 1894.	1895.	1896.	Closing Quotation, Aug. 11th.	Closing Quotation, Aug. 18th.	Business done during week ended Aug. 18th, 1897. Highest.	Lowest
149,900£	African Direct Teleg., Ltd., 4 % Deb.	£100	4 %	4 %	...	99 —103	99 —103	101	...
25,000	Amazon Telegraph, Limited, shares...	10	...	...	...	5 — 6	5 — 6	...	...
923,960£	Anglo-American Teleg., Ltd.	Stock	£2 2s.	£2 9s.	£2 13s.	54 — 57	54 — 57 xd	56⅜	...
3,038,020£	Do. do. 6 % Pref.	Stock	£4 4s.	£4 18s.	£5 6s.	101 — 102	101 — 102	102	101
3,038,920£	Do. do. Defd.	Stock	...	...	...	10¼— 10⅜	10¼— 11	10⅞	10⅜
130,000	Brazilian Submarine Teleg., Ltd.	10	7 %	7 %	...	15 — 15½	15 — 15½	15⅝	15⅛
75,000£	Do. do. 5 %, Debs., 2nd series, 1926	100	5 %	5 %	...	113 —117	113 —117	...	...
44,000	Chili Telep., Ltd., Nos. 1 to 44,000	5	2½%	4 %	4 %	3½— 3⅝	3½— 3⅝xd	...	...
10,000,000$	Commercial Cable Co.	$100	7 %	7 %	7 %	170 —175	170 —175	...	...
653,586£	Do. Do. Sterling 500 year 4% Deb. Stock Red.	Stock	...	...	...	106 —107	106 —107	107	106¼
224,850	Consolidated Teleg. Const. and Main., Ltd.	10/-	1½%	1½%	2 %	3/16— 4/16	3/16— 4/16	...	...
16,000	Cuba Teleg., Ltd.	10	8 %	8 %	8 %	9 — 10	9 — 10	9¾	...
6,000	Do. 10 % Pref.	10	10 %	10 %	10 %	19 — 20	19 — 20	...	...
12,931	Direct Spanish Teleg., Ltd.	5	4 %	4 %	4 %	3½— 4½	3½— 4½	...	...
6,000	Do. do. 10 % Cum. Pref.	5	10 %	10 %	10 %	9½— 10½	9½— 10½	...	...
30,000£	Do. do. 4½ % Debs. Nos. 1 to 6,000 ...	50	4½%	4½%	4½%	103 —106%	103 —106 %	...	...
60,710	Direct United States Cable, Ltd.	20	2 %	2½%	2½%	9½— 10	9½— 10	9⅞	9 11/16
400,000	Eastern Teleg., Ltd., Nos. 1 to 400,000	10	6½%	6½%	6½%	16⅝— 17¼	16⅝— 17¼	17⅛	16¾
70,000	Do. 6 % Cum. Pref.	10	6 %	6	6%	18 — 19	17½— 18½	18¼	18
89,900£	Do. 5 % Debs., repay. August, 1899	100	5 %	5 %	5%	101 —104	101 —104 xd	101⅛	...
1,302,615£	Do. 4 % Mort. Deb. Stock Red.	Stock	4 %	4 %	4%	128 —131	128 —131	...	...
250,000	Eastern Extension, Australasia and China Teleg., Ltd. ...	10	7 %	7 %	7⅛	17½— 18	17½— 18	18⅛	17 13/16
35,500£	Do. 5 % (Aus. Gov. Sub.), Deb., 1900, red. ann. drgs. reg. 1 to 1,049, 3,976 to 4,326	£100	5 %	5 %	5%	99 —103	99 —103	...	...
133,100£	Do. do. Bearer, 1,050—3,975 and 4,327—6,400	100	5 %	5 %	5%	100 —103	100 —103	100⅜	...
320,000£	Do. 4 % Deb. Stock	Stock	4 %	4 %	4%	128 —131	128 —131 xd	...	...
51,100£	Eastern and South African Teleg., Ltd., 5 % Mort. Deb. 1900 redeem. ann. drgs., Reg. Nos. 1 to 2,343	£100	5 %	5 %	5%	99 —103	99 —103	...	...
69,200£	Do. do. to bearer, 2,344 to 5,500	100	5 %	5 %	5%	100 —103	100 —103	...	...
300,000£	Do. 4 % Mort. Debs. Nos. 1 to 3,000, red. 1909	£100	4 %	4 %	4%	103 —106	103 —105xd	...	...
200,000£	Do. 4 % Reg. Mt. Debs. (Mauritius Sub.) 1 to 8,000	25	4 %	4 %	4%	107 —110%	107 —110 %	...	...
180,227	Globe Telegraph and Trust, Ltd.	10	4½%	4½%	4½%	11½— 12	11½— 12	11⅝	11 9/16
180,042	Do. do. 6 % Pref.	10	6 %	6 %	6%	16¾— 17¼	16⅝— 17¼	17⅛	16⅝
150,000	Great Northern Teleg. Company of Copenhagen	10	8⅝%	10 %	10⅞	26½— 27½	26½— 27½	...	...
160,000£	Do. do. do. 5 % Debs.	100	5 %	5 %	5⅞	104 —107	104 —107	...	...
17,000	Indo-European Teleg., Ltd.	25	10 %	10 %	10⅞	54 — 57	54 — 57	54½	54
100,000£	London Platino-Brazilian Teleg., Ltd. 6 % Debs.	100	6 %	6 %	6%	107 —110	107 —110	...	...
28,000	Montevideo Telephone 6% Pref., Nos. 1 to 28,000... ...	5	4 %	4 %	...	2 — 2¼	2 — 2¼	...	...
484,597	National Teleph., Ltd., 1 to 484,597	5	5 %	5⅛%	5⅛%	6¼ — 6⅜	6¼ — 6⅜	6 7/16	6 5/16
15,000	Do. 6 % Cum. 1st Pref.	10	6 %	6 %	6 %	15 — 17	15 — 17	...	...
15,000	Do. 6 % Cum. 2nd Pref.	10	6 %	6 %	6 %	15 — 17	15 — 17	16	...
119,234	Do. 5 % Non-cum. 3rd Pref., 1 to 119,234	5	5 %	5 %	5 %	6 — 6½	6 — 6½	6 1/16	...
1,329,471£	Do. 3½ % Deb. Stock Red.	Stock	3½%	3½%	3½%	105 —110	105 —110	...	...
171,504	Oriental Teleph. & Elec., Ltd., Nos. 1 to 171,504, fully paid	1	4½%	5 %	5 %	⅜— ½	⅜— ½	...	...
100,000£	Pacific and European Tel., Ltd., 4 % Guar. Debs, 1 to 1,000	£100	4 %	4 %	4 %	107 — 110	107 —110	...	...
11,839	Reuter's Ltd.	8	nil	5 %	5 %	7 — 8	7 — 8	...	...
3,381	Submarine Cables Trust	Cert.	...	...	...	135 —140	135 —140	138	136¼
58,000	United River Plate Teleph., Ltd.	5	3 %	4 %	...	3½— 4	3½— 4⅛	...	...
146,733£	Do. do. 5 % Debs.	Stock	5 %	5 %	...	100 —105	100 -105	106½	105
15,609	West African Teleg., Ltd., 7,501 to 23,109	10	nil	4 %	nil	5 — 6	5 — 6	...	...
213,400£	Do. do. do. 5 % Debs.	100	5 %	5 %	5 %	102 - 105	104 - 107	...	...
64,256	Western and Brazilian Teleg., Ltd.	15	3 %	3 %	2 %	9 — 9½	9 — 9½	...	...
33,129	Do. do. do. 5 % Pref. Ord. ...	7½	5 %	5 %	5 %	6⅝ — 7¼	6⅝ — 7¼	7¼	6⅞
33,129	Do. do. do. Def. Ord ...	7½	1 %	1 %	...	2¼— 2⅜	2¼— 2⅜	...	...
382,230	Do. do. do. 4 % Deb. Stock Red. ...	Stock	...	...	...	101 —104	101 —104	103	...
88,321	West India and Panama Teleg., Ltd.	10	⅛%	⅛%	1 %	⅜— 1½	⅜— 1½	...	...
34,563	Do. do. do. 6 % Cum. 1st Pref.	10	6 %	6 %	6 %	10 — 10½	10 — 10½	10½	...
4,669	Do. do. do. 6 % Cum. 2nd Pref	10	6 %	6 %	6 %	8½ — 9½	8½ — 9½	...	...
80,000£	Do. do. 5 % Debs. No. 1 to 1,800 ...	100	5 %	5 %	5 %	105 —108	105 —108	107	...
1,163,000$	Western Union of U. S. Teleg., 7 % 1st Mort. Bonds ..	$1000	7 %	7 %	7%	104 —108	106 —110	...	...
160,100	Do. do. 6 % Star. Bonds.	100	6 %	6 %	6%	100 —105	102 —106	...	...

ELECTRICITY SUPPLY COMPANIES.

30,000	Charing Cross and Strand Electy. Supply	5	4½%	5 %	6 %	12½— 13½	12½— 13½	...	...
20,000	Do. do. do. do. 4½ % Cum. Pref.	5	...	...	...	6 — 6½	6 — 6½	6 5/16	6
26,000	*Chelsea Electricity Supply, Ltd., Ord., Nos. 1 to 10,277 ...	5	5 %	5 %	5 %	9¾— 10¼	9¾— 10¼	10 5/16	9¾
60,000	Do. do. do. 4½ % Deb. Stock Red. ...	Stock	...	4½%	4½%	110 —113	110 —113	...	...
40,000	City of London Elec. Lightg. Co., Ltd., Ord. 40,001—80,000	10	5 %	5 %	7 %	23½— 24½	23½— 24½	24⅛	24
40,000	Do. do. 6 % Cum. Pref., 1 to 40,000	10	6 %	6 %	6 %	16⅜— 17½	16½— 17½	17⅜	17¼
400,000	Do. 5 % Deb. Stock, Scrip. (iss. at £115) all paid	...	5 %	5 %	5 %	130 —135	130 —135	132½	...
22,475	County of Lond. & Brush Prov. E. Ltg. Ltd., Ord. 1—22,475	10	...	nil	nil	12¾— 13¼	12¾— 13¼	...	...
20,000	Do. do. do. 6% Pref., 40,001— 60,000 ...	10	...	6 %	6 %	15 — 15½	15 — 15½xd	15⅝	15½
10,000	House-to-House Elec. Light Supply, Ord., 101 to 10,100	5	...	...	...	8¾— 9¼	9 — 9½	9⅛	9
49,900	*Metropolitan Electric Supply, Ltd., 101 to 50,000 ...	10	3 %	4 %	5 %	16½— 17⅛	16½— 17½	...	...
12,500	Do. Ord., 50,001—62,500, iss. at £2 prem. ...	10	...	...	...	15½— 16½	16 — 17	16½	16¼
220,000	Do. 4½% first mortgage debenture stock	...	4½%	4½%	4½%	118 —122	118 —122	...	...
6,452	Notting Hill Electric Lightg. Co., Ltd.	10	1 %	2 %	4 %	15 — 16	15 — 16	...	...
19,980	*St. James's & Pall Mall Elec. Light Co., Ltd., Ord., 101-20,080	5	6⅛%	7½%	10⅛%	16½ - 17½	17 — 18	17½	17⅜
20,000	Do. do. 7 % Pref., 20,081 to 40,080	5	7 %	7 %	7 %	10 — 11	10 — 11 xd	...	...
50,000	Do. do. 4 % Deb. stock Red. ...	Stock	...	...	...	102 —105	102 —105	...	...
67,900	*Westminster Electric Supply Corp., Ord. 101 to 80,000	5	5 %	7 %	9 %	14½— 15½	14½— 15½xd	15⅛	14 13/16

* Subject to Founder's Shares.
‡ Unless otherwise stated all shares are fully paid.
§ Dividends marked § are for a year consisting of the latter part of one year and the first part of the next.
† Quotations on Liverpool Stock Exchange.
‖ Dividends paid in deferred share warrants, profits being used as capital.

SHARE LIST OF ELECTRICAL COMPANIES—*Continued*

ELECTRICAL RAILWAY, MANUFACTURING, AND INDUSTRIAL, COMPANIES.

Present Issue.	NAME.	Stock or Share. ‡	Dividends for the last three years. 1894.	1895.	1896.	Closing Quotation, August 11th.	Closing Quotation Aug. 18th.	Business done during week ended Aug. 18th, 1897. Highest.	Lowest.
20,000	British Electric Traction	10	...	...	...	13 — 13½	13¼ — 13⅜	13⅛	13 5/16
90,000	Brush Elecl. Enging. Co., Ord., 1 to 90,000...	3	2½%	...	...	⅞ — 1⅛	¼ — 1⅛	...	...
90,000	Do. do. Non-cum. 6 % Pref., 1 to 90,000	2	3 %	...	...	1½ — 1⅝	1½ — 1⅝	...	...
125,000£	Do. do. 4½ % Perp. Deb. Stock.... ...	Stock	4½%	...	...	105 —109	105 —109	107¼	...
76,770	Do. do. 4½% 2nd Deb. Stock Red. ...	Stock	...	...	...	93 — 97	93 — 97	...	...
19,126	Central London Railway, Ord. Shares	10	...	...	...	9⅜ — 10¼	9⅜ — 10¼	10⅛	9 15/16
143,105	Do. do. do. £6 paid	10	...	...	...	5⅞ — 6¼	5⅞ — 6¼	5⅞	...
58,830	Do. do. Pref. half-shares £1 pd. ...	...	...	...	...	1¼ — 1⅜	1¼ — 1⅜	...	...
61,777	Do. do. Def. do. £5 pd. ...	...	...	...	...	4¼ — 4⅜	4¼ — 4⅜	...	...
630,000£	City and South London Railway	Stock	1½%	1 3/16%	1 9/16%	65 — 67	65 — 67	66½	65
28,180	Crompton & Co., Ltd., 7 % Cum. Pref. Shares, 1 to 28,180	5	*nil*	*nil*	...	1½ - 2	1½ — 2	...	...
89,261	Edison & Swan United Elec. Lgt., Ltd., "A" shrs, £3 pd. 1 to 89,261	5	5 %	5 %	...	2¼ — 2⅜	2¼ — 2⅜xd	...	...
17,139	Do. do. do. "A" Shares 01—017,139	5	5 %	5 %	...	4¼ — 4⅜	4¼ — 4⅜	4	...
110,000	Electric Construction, Ltd., 1 to 110,000	2	*nil*	5 %	5½%	1⅞ — 2	1⅞ — 2	1 15/16	1 13/16
16,343	Do. do. 7 % Cum. Pref., 1 to 12,845 ...	2	7 %	7 %	7 %	2⅝ — 3¼	2⅝ — 3¼	...	...
91,195	Elmore's Patent Cop. Deposg., Ltd., 1 to 70,000	2	*nil*	...	...	¾ — 1	¾ — 1	...	...
67,275	Elmore's Wire Mfg., Ltd., 1 to 69,385, issued at 1 pm. ...	2	*nil*	...	...	½ — ¾	½ — ¾	...	...
9,600£	Greenwood & Batley, Ltd., 7 % Cum. Pref., 1 to 9,600 ...	10	*nil*	10½%	...	9 — 11	9 — 11	...	...
12,500	Henley's (W. T.) Telegraph Works, Ltd., Ord.	10	6 %	8 %	10 %	18½ — 19½	18½ — 19½	...	...
3,000	Do. do. do. 7% Pref.	10	7 %	7 %	7 %	18½ — 19½	18½ — 19½	...	...
50,000	Do. do. do. 4½ Mort. Deb. Stock	Stock	...	4½%	4½%	108 —113	108 —113	...	...
50,000	India-Rubber, Gutta Percha and Teleg. Works, Ltd. ...	10	10 %	10 %	10 %	20½ — 21½	20½ — 21½	21	20¾
300,000	Do. do. do. 4 % 1st Mort. Debs.	100	...	...	...	105 —108	105 —108	...	...
27,500	†Liverpool Overhead Railway, Ord.	10	1½%	2⅜%	2⅜%	12⅛ — 12½	11⅞ — 12 xd	...	..
10,000	† Do. do. Pref., £10 paid	10	5 %	5 %	5 %	15½ — 16	15⅞ — 16⅛xd	...	...
37,350	Telegraph Constn. and Maintce., Ltd.	12	20 %	15 %	15 %	37 — 40	37 — 40	39½	38½
150,000	Do. do. do. 5 % Bonds, red. 1899	100	5 %	5 %	5 %	102 —105	102 —105	...	...
54,000£	Waterloo and City Railway, Nos. 1 to 54,000, £8 paid ...	10	...	...	...	10⅞ — 11⅛	10⅞ — 11⅛	11⅛	10⅞

Quotations on Liverpool Stock Exchange. ‡ Unless otherwise stated all shares are fully paid. ¶ Last dividend paid was 50 % for 1890.
Dividends marked § are for a year consisting of the latter part of one year and the first part of the next.
Crompton & Co.—The dividends paid on the ordinary shares (which have not a Stock Exchange quotation), are as follows: 1892—0%; 1891—7½%; 1890—8%

LATEST PROCURABLE QUOTATIONS OF SECURITIES NOT OFFICIALLY QUOTED.

* Birmingham Electric Supply Company, Ordinary of £5 (£4 paid), 7⅞, £5 (fully paid) 9½.

Electric Construction Corporation, 6 % Debentures, 103—106.

House-to-House Company, 7 % Preference, of £5, 10½—11.

Do. do. 4½% Debentures of £100, 108 —110.

* From Birmingham Share List.

Kensington and Knightsbridge Electric Lighting Company, Limited, Ordinary Shares £5 (fully paid) 13—13½; 1st Preference Cumulative 6 %, £5 (fully paid), 8¼ —8⅝. Dividend, 1896, on Ordinary Shares 7 %.

London Electric Supply Corporation, £5 Ordinary, 1⅞—2.

Yorkshire House-to-House Electricity Company, £5 Ordinary Shares fully paid, 8—8½. Dividend for 1896—6 %.

Bank rate of discount, 2 per cent. (May 13th, 1897).

THE EARTH, A GREAT MAGNET.*

By Dr. J. A. FLEMING, M.A., F.R.S.,
Professor of Electrical Engineering in University College, London.

(*Concluded from page* 228.)

Gilbert's particular astronomical notions were soon stripped away; but inside the husk of theory there was the kernel of a valuable truth, and it remained as the essence of what Gilbert gave us in his great book, "De Magnete," published in 1600, A.D.

All that has been done since that date has been to build up an irrefutable body of proof, some part of which we shall presently review; but Gilbert with his lodestone balls first grasped the essential idea that the earth we live on has magnetic properties as a whole, and acts as a colossal magnet—all little magnets anywhere on its surface setting themselves in obedience to its magnetic force, and turning their poles to point to its great magnetic poles, just as fragments of magnetised needles placed themselves on his earthkin, fashioned from a lodestone as a model of the earth. Gilbert thus destroyed the erroneous notion that the directive power of the compass needle was due to any cause outside the earth, and he fastened our attention in regarding its behaviour, not on the attraction of a pole star or a celestial pole, but on the magnetic qualities of the earth itself.

We must then turn to consider the facts in support of this conception, and first make reference to two historical discoveries—one, that of Columbus, who discovered the "variation" of the needle; and the other, that of Hartmann and Norman, who discovered the "dip."

In Columbus's first voyage to America, on the evening of September 13th, 1492, he noticed that the magnetic needle did not point exactly to the pole star, and that as he went westward this deviation increased. Up to that time no one had noted the fact that the needle did not everywhere point to the true North Pole; but the voyage of discovery which revealed the new world, opened up also a fresh discovery in magnetism, and the variation of the needle from the true geographical meridian, or north and south line, became a recognised fact. Two other things also about it became later known—one, that this variation is not the same at different places; and the other, that the variation itself varies at any one place. It appears that the first careful measurements of this variation were made in England by Burroughs, comptroller of the navy in the reign of Elizabeth. At that time in England the needle varied 11° 15′ east of north. Since that date, the variation gradually changed in the manner shown in the following table:—

Date.	Mean variation of needle in London.	Date.	Mean variation of needle in London.
1580	11° 15′ E	1787	23 19′ W
1622	6 0 „	1795	23 57 „
1634	4 6 „	1802	24 6 „
1657	0 0 „	1805	24 8 „
1665	1 22 W	1818	24 34 „
1672	2 30 „	1858	21 54 „
1692	6 0 „	1862	21 23 „
1723	14 17 „	1894	17 23 „
1748	17 40 „	1895	17 17 „

The compass needle in England has in the last 300 years, therefore, been very slowly changing its mean direction.

In Queen Elizabeth's reign it pointed 11° east of north, or about one point east; in the days of the Commonwealth, it had returned to point due north. It then slowly marched westward, and three years after the battle of Waterloo it reached in London its greatest westerly excursion of 24½° west. Since that time it has been gradually diminishing again. In all places there is a corresponding kind of secular change, as it is called, in the position of the needle. Encircling the earth there is an irregular line, called the line of no variation, and along that line (which is slowly changing its place) the compass needle is directed in a true north and south direction. This fact gives you your first glance at the truth that the earth's magnetism is not fixed, but is in a constant state of change; and more, not only are there these great and slow changes of position in the needle at any one spot, but there are small daily and yearly movements of the needle, which are regularly repeated, and also certain very irregular sudden motions, of which more shall be said presently.

Then as regards the "dip" of the needle, Norman, in 1576, first announced, in a little book called the "New Attractive," the fact that if a steel needle, carefully balanced and free to move in a vertical plane, is magnetised, it dips downward by a certain angle called the "dip."

* A lecture delivered to the working men of Liverpool, September 19th, 1896, and published in the June issue of *Terrestrial Magnetism*.

At one spot in each hemisphere of the earth there is a place where such a dipping needle stands vertically, and these places are called the earth's magnetic poles. These magnetic poles do not coincide with the true geographical poles. There is an irregular line round the earth on all points of which the needle sets itself horizontally, and this line is called the magnetic equator. This terrestrial "pole of verticity" was reached by Sir James Ross in his Arctic expedition in 1831; and he found the dip needle pointed vertically to the earth's surface at a spot in the north of North America. Its position he determined to be latitude 70° 5′ 17″ N, and longitude 96° 45′ 48″ W. This locality agrees very well with a position determined by calculation by the great mathematician Gauss.

It only remains to be said that the "dip" at any place has its slow periodic, its daily and its yearly changes, like the variation.

In the next place, I wish to point out to you that as a first approximation, but only very roughly, we can imitate this magnetic condition of the earth by a model globe, having a short magnet stuck through its centre, but with its axis oblique, or inclined, to the true polar axis of the globe. If we construct such a model and carry round it to different places a small magnetic needle, we are able to show that there would be two places where the dip would be 90°, and also that there would be a variation of the needle and a line of no variation. We may also imitate in a very rough way, the changes of declination by supposing this internal magnet to revolve round, keeping its axis always at about the same inclination to the earth's polar axis.

But the progress of knowledge soon showed that this rough hypothesis is by no means sufficient to explain even approximately all the facts.

Long ago it was felt that, as a first step towards better knowledge, a complete magnetic survey of the globe was an imperative necessity, and also the establishment of magnetic observatories in various places to record the magnetic changes, and measure the magnetic elements. Accordingly, at Kew, and at many other places, such magnetic observatories were established; and in numerous expeditions, public and private, magnetic measurements have been made, at hundreds of places on the earth's surface, of the variation of the needle, the dip of the needle, and the earth's magnetic force or field, and the results have been embodied in magnetic charts.

These charts exhibit the isogonic lines, or lines joining places of equal variation; isoclinic lines, or lines joining places of equal dip; and isodynamic lines, or lines joining places of equal magnetic force. The irregular distribution of magnetism, as shown by these charts, can not be reconciled with the supposition that the earth acts as a simple magnet.

At magnetic observatories, such as Kew, the elements are constantly recorded by photography, and the movement of a spot of light, reflected from a mirror fixed to the magnet, is made to record on photographic paper a curve, showing the changes from moment to moment in the different elements. "On that paper the never-resting heart of the earth traces, in telegraphic symbols, the record of its pulsations, and also the slow but mighty working of the changes which warn us not to suppose that the inner history of our planet is ended." (Maxwell.)

The diagram before you represents a part of such a two-days' diagram for the instruments at the Kew Magnetic Observatory, measuring the declination or variation and the earth's horizontal and vertical magnetic force. These photographic records, which have been kept at Kew for over a quarter of a century, show that, in addition to these slow, regular changes, the earth's magnetism is frequently in a state of more or less violent disturbances, and these disturbances are called *magnetic storms*.

A magnetic storm may be going on when the sky is cloudless and air calm. Magnetic storms are intimately connected in some way, we know not yet how, with changes on the sun's surface, producing sun-spots, and they always accompany displays of that electrical appearance called the aurora, so frequent in higher latitudes and especially so near the earth's magnetic poles.

There is a close connection between all these phenomena. The years of most frequent sun-spots are separated from each other by a period of about eleven years, and the years of the greatest number of magnetic storms, and also of auroras, appear to coincide with those years of the maximum number of sun spots.

Thus the year 1859 was a year of maximum number of sun spots, and it was a year of great magnetic disturbances. Again, 1870-1871 was remarkable as a year for numerous sun spots and magnetic storms, and of frequent auroras, seen even as low down as London.

Our modern investigations lead, therefore, to the conclusion that the earth is alive with ever-changing magnetic forces, and its magnetic state at any point is not only altering in a slow progressive manner, like the solemn march of constellations in the heavens, but has its daily tides like the ocean, and also, like the restless sea, is ever and again thrilled with little ripples or waves of changing magnetism, or lashed into a furious magnetic storm.

These periods of magnetic storm coincide with times of great activity on the sun's surface, as evidenced by the presence of numerous sun spots.

The earth may therefore be described as a very irregularly magnetised magnet, with a pole magnetically similar to that which we call the south pole of a magnet somewhere on the north of North America, and an opposite pole somewhere in the Antartic Ocean, but not at opposite ends of a diameter, and at some distances from the geographical poles. This great magnet is undergoing small, but fairly regular daily and yearly magnetic changes, and also sudden, irregular, and sometimes very great magnetic changes, called disturbances or storms.

We have said that we cannot explain the facts of the earth's magnetism merely on the supposition that it is a single magnet. One proof of this is that there are two places in the northern hemisphere —one in the north of Canada and the other in the north of Siberia— where the terrestrial magnetic force has a maximum value, and these are called the magnetic foci.

Leading authorities have contended that we cannot explain facts of the earth's magnetic condition without admitting that there are two systems of magnetism super-imposed, one having reference to the stronger focus in Canada, and the other to the weaker in Siberia.

Halley, and since his time others, have endeavoured to account for the slow secular changes of the declination by the revolution of the Siberian focus round the globe, but the most recent discussion of the facts does not give support to this idea, but rather to the view that slow changes are taking place at many points.

Then arises another question. What is the cause of the earth's magnetism?

There are two ways in which we can produce a magnetic field— one by means of permanently magnetised steel or iron, and the other by sending an electric current through a conducting circuit. Hence the earth's magnetic condition may arise either from the materials of which it is made being permanently magnetised like lodestone, or it may arise from electric currents circulating round the earth in its crust, or from both causes together. We know that there *are* such earth currents, but we are at present unable to say whether the magnetic state of the earth has arisen as a consequence of these earth currents or is merely influenced by them.

If the magnetic state arises from a permanent magnetisation of the materials of which the earth is made, then it must be wholly confined to the outer layer of the earth's crust, say within a depth of 10 or 12 miles. We know that as we descend into the earth, the temperature rises at the rate of about 1° F. for each 50 feet of descent. An easy calculation, then, shows us that at a depth of about 12 miles the temperature would be about 1,200° F., which is a bright red heat. At this temperature iron and lodestone and steel become quite non-magnetisable. A red-hot iron ball is not attracted by a magnet, and a magnet heated red-hot becomes demagnetised. The fact that a lodestone lost is magnetic power on heating in the fire was known to Fra Paolo and Porta in 1590.

Hence it is quite clear that if the earth is magnetic in the sense in which a lodestone is magnetic, that it is not magnetic in the interior, but only on a relatively thin layer on the outside. For the earth is 8,000 miles in diameter, and 12 miles is only $\frac{1}{333}$ of 4,000.

Imagine a globe six inches in diameter representing the earth. We may take one-hundredth of an inch as the thickness of a sheet of writing paper. If such a globe was covered with writing paper, the thickness of that paper would represent to the same scale a depth of twelve miles. Hence we may say we live on the thin cool skin of a red-hot or white-hot globe, incandescent, but not fluid, in the interior.

No permanently magnetised material can exist much below this thin skin or crust of about twelve miles thick.

If, on the other hand, the magnetic powers of the earth are due to electric currents circulating in the mass of the earth, these may exist at much greater depths than twelve miles, because the very rise of temperature, which destroys permanent magnetism, probably renders the incandescent interior of the earth a much better electric conductor than the cooler exterior rocks.

Professors Rücker and Thorpe, in an elaborate magnetic survey of the British Islands, have come to the conclusion that many of the irregularities of the surface magnetic effects on the earth are to be attributed to the magnetic attraction of magnetised masses of rock below the surface, and since we know that the mean density of the earth is more than twice as great as the average density of rocks at the surface, it may well be that before we reach the limit below which permanent magnetism is impossible, there may exist a layer of earth crust in which iron compounds, or iron, form such a predominant constituent that it possesses a high general magnetisation, which, in consequence of changing temperature, is undergoing great magnetic changes.

It would need almost a lecture in itself to give you an idea of the many different suppositions which have been made to account for the mode by which the earth became a magnet. Taken as a whole, it is a feeble magnet.

If our globe were wholly made of steel, and magnetised as highly as an ordinary steel bar magnet, the magnetic forces at its surface would be at least a hundred times as great as they are now. That might be an advantage or a very great disadvantage.

The remarkable fact about the earth's magnetic state is, that the two hemispheres, northern and southern, are magnetically different. In other words, there is a want of symmetry. Now the one great natural phenomenon with which it agrees in this respect is that of the earth's rotation, and there are many lines of thought which lead to the notion that the earth's magnetic state may have been originally produced by, even if it is not maintained by, the earth's diurnal or daily rotation.

Many are the hypotheses which have been put forward to account for the close connection between sun-spots, auroras, magnetic storms, and earth currents. One of the most ingenious of these is due to Sir George Stokes.

Then, leaving speculations for which we have but slender ground, let me show you, in conclusion, some effects which the earth as a great magnet can produce, in which it acts just as do our smaller magnets in the workshop or laboratory.

You have already seen that a piece of iron placed in the field of a magnet becomes itself magnetised. In like manner every piece of iron, which has stood long in a direction nearly coinciding with the earth's magnetic force, is magnetised. Hence, in England, where the dip is nearly 70°, all vertical bars of iron are magnetic. If you try with a little pocket compass, you will find all iron pillars, or long iron pipes in a vertical position are magnets, and have a north pole at the lower end; try, even with a pocket compass, iron railings in

front of a kitchen area, and you will find the same. This fact was known to Gilbert.

Hammering a bar of iron, placed in the north and south position, facilitates the acquirement of this earth-produced magnetism; and the magnetism so produced in the framework and shell of iron ships is a cause of great disturbance of the compasses in them, which requires correction.

Then, in the next place, a magnet can create an electric current in a coil of wire when it is moved to and from it. This was discovered by Faraday in 1831. In like manner, turning or moving a coil of wire over in front of the earth in such manner that a change is made in the apparent size of the coil, when looked at in the direction of the earth's magnetic force, will create an electric current in the coil. This is the principle underlying the dynamo machine. Lastly, if a movable coil of wire has an electric current sent through it, when that coil is appropriately placed in front of a magnet, it will cause the coil to move, and we have here the fundamental principle of the electric motor.

Mr. Swan has constructed and lent to me a coil of wire called a Gramme ring, which is so delicately poised that when a current of electricity is sent through the coil, it is caused to rotate by the magnetism of the earth. We are using, in this experiment, the earth as the field magnet of our motor.

Here, then, are three lines of proof which sustain the argument, which has been the subject of my discourse, viz., that the earth is a great magnet.

No words are needed to enforce the enormous value of that fact in its intimate relation to the art of navigation.

To us as a maritime nation, to you who are inhabitants of a maritime city, the progress of a knowledge of terrestrial magnetism, the improvements in the compass, the study of the causes of error in iron ships, in short, everything connected with the use and evolution of the compass, is of unspeakable importance. Time has failed me to even mention the invaluable contributions of Lord Kelvin to this particular part of the subject.

That great empire which has its centre in these islands, but its dominions scattered over distant seas, has been built up primarily on the art of navigation, in which the magnetism of the earth is a central fact. Neither its world-wide commerce, nor the naval power which defends its coasts, could exist for a day without the aid of the magnetic compass. But our globe, as it spins through space, is clothed, as it were, in a gossamer garment woven of lines of magnetic force, and this little trembling needle serves as a sensitive finger, whereby we track out the path of these invisible clues, and confidently determining our direction, though wandering over wide waters, wrapped, it may be, in darkness or in storm, are enabled thereby to establish a continual intercourse between all portions of the habitable globe.

BRITISH ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE.—TORONTO, 1897.

ADDRESS TO THE CHEMICAL SECTION.*

By Professor William Ramsay, Ph.D., LL.D., Sc.D., F.R.S.,
President of the Section.

An Undiscovered Gas.

A sectional address to members of the British Association falls under one of three heads. It may be historical, or actual, or prophetic; it may refer to the past, the present, or the future. In many cases, indeed in all, this classification overlaps. Your former presidents have given sometimes a historical introduction, followed by an account of the actual state of some branch of our science, and, though rarely, concluding with prophetic remarks. To those who have an affection for the past, the historical side appeals forcibly; to the practical man and to the investigator engaged in research, the actual, perhaps, presents more charm; while to the general public, to whom novelty is often more of an attraction than truth, the prophetic aspect excites most interest. In this address I must endeavour to tickle all palates; and perhaps I may be excused if I take this opportunity of indulging in the dangerous luxury of prophecy, a luxury which the managers of scientific journals do not often permit their readers to taste.

The subject of my remarks to-day is a new gas. I shall describe to you later its curious properties; but it would be unfair not to put you at once in possession of the knowledge of its most remarkable property—it has not yet been discovered. As it is still unborn, it has not yet been named. The naming of a new element is no easy matter. For there are only 26 letters in our alphabet, and there are already over 70 elements. To select a name expressible by a symbol which has not already been claimed for one of the known elements is difficult, and the difficulty is enhanced when it is at the same time required to select a name which shall be descriptive of the properties (or want of properties) of the element.

It is now my task to bring before you the evidence for the existence of this undiscovered element.

It was noticed by Döbereiner, as long ago as 1817, that certain elements could be arranged in groups of three. The choice of the elements selected to form these triads was made on account of their analogous properties, and on the sequence of their atomic weights, which had at that time only recently been discovered. Thus calcium, strontium, and barium formed such a group: their oxides, lime, strontia, and baryta are all easily slaked, combining with water to form soluble lime-water, strontia-water, and baryta-water. Their sulphates are all sparingly soluble, and resemblance had been noticed between their respective chlorides and between their nitrates. Regularity was also displayed by their atomic weights. The numbers then accepted were 20, 42·5 and 65; and the atomic weight of strontium, 42·5, is the arithmetical mean of those of the other two elements, for $(65 + 20) / 2 = 42{\cdot}5$. The existence of other similar groups of three was pointed out by Döbereiner, and such groups became known as "Döbereiner's triads."

Another method of classifying the elements, also depending on their atomic weights, was suggested by Pettenkofer, and afterwards elaborated by Kremers, Gladstone, and Cooke. It consisted in seeking for some expression which would represent the differences between the atomic weights of certain allied elements. Thus, the difference between the atomic weight of lithium, 7, and sodium, 23, is 16; and between that of sodium and of potassium, 39, is also 16. The regularity is not always so conspicuous; Dumas, in 1857, contrived a somewnat complicated expression which, to some extent, exhibited regularity in the atomic weights of fluorine, chlorine, bromine, and iodine; and also of nitrogen, phosphorus, arsenic, antimony, and bismuth.

The upshot of these efforts to discover regularity was that, in 1864, Mr. John Newlands, having arranged the elements in eight groups, found that when placed in the order of their atomic weights, "the eighth element, starting from a given one, is a kind of repetition of the first, like the eighth note of an ocatve in music." To this regularity he gave the name "The Law of Octaves."

The development of this idea, as all chemists know, was due to the late Prof. Lothar Meyer, of Tübingen, and to Prof. Mendeléeff, of St. Petersburg. It is generally known as the "Periodic Law." One of the simplest methods of showing this arrangement is by means of a cylinder divided into eight segments by lines drawn parallel to its axis; a spiral line is then traced round the cylinder, which will, of course, be cut by these lines eight times at each revolution. Holding the cylinder vertically, the name and atomic weight of an element is written at each intersection of the spiral with a vertical line, following the numerical order of the atomic weights. It will be found, according to Lothar Meyer and Mendeléeff, that the elements grouped down each of the vertical lines form a natural class: they possess similar properties, form similar compounds, and exhibit a graded relationship between their densities, melting points, and many of their other properties. One of these vertical columns, however, differs from the others, inasmuch as on it there are three groups, each consisting of three elements with approximately equal atomic weights. The elements in question are iron, cobalt, and nickel; palladium, rhodium, and ruthenium; and platinum, iridium, and osmium. There is apparently room for a fourth group of three elements in this column, and it may be a fifth, And the discovery of such a group is not unlikely, for when this table was first drawn up Prof. Mendeléeff drew attention to certain gaps, which have since been filled up by the discovery of gallium, germanium, and others.

The discovery of argon at once raised the curiosity of Lord Rayleigh and myself as to its position in this table. With a density of nearly 20, if a diatomic gas, like oxygen and nitrogen, it would follow fluorine in the periodic table; and our first idea was that argon was probably a mixture of three gases, all of which possessed nearly the same atomic weights, like iron, cobalt, and nickel. Indeed, their names were suggested, on this supposition, with patriotic bias, as Anglium, Scotium, and Hibernium! But when the ratio of its specific heats had, at least in our opinion, unmistakably shown that it was molecularly monatomic, and not diatomic, as at first conjectured, it was necessary to believe that its atomic weight was 40, and not 20, and that it followed chlorine in the atomic table, and not fluorine. But here arises a difficulty. The atomic weight of chlorine is 35·5, and that of potassium, the next element in order in the table, is 39·1; and that of argon, 40, follows, and does not precede, that of potassium, as it might be expected to do. It still remains possible that argon, instead of consisting wholly of monatomic molecules, may contain a small percentage of diatomic molecules; but the evidence in favour of this supposition is, in my opinion, far from strong. Another possibility is that argon, as at first conjectured, may consist of a mixture of more than one element; but, unless the atomic weight of one of the elements in the supposed mixture is very high, say 82, the case is not bettered, for one of the elements in the supposed trio would still have a higher atomic weight than potassium. And very careful experiments, carried out by Dr. Norman Collie and myself, on the fractional diffusion of argon, have disproved the existence of any such element with high atomic weight in argon, and, indeed, have practically demonstrated that argon is a simple substance, and not a mixture.

The discovery of helium has thrown a new light on this subject. Helium, it will be remembered, is evolved on heating certain minerals, notably those containing uranium; although it appears to be contained in others in which uranium is not present, except in traces. Among these minerals are clèveite, monazite, fergusonite, and a host of similar complex mixtures, all containing rare elements, such as niobium, tantalum, yttrium, cerium, &c. The spectrum of helium is characterised by a remarkably brilliant yellow line, which had been observed as long ago as 1868 by Profs. Frankland and Lockyer in the spectrum of the sun's chromosphere, and named "helium" at that early date.

The density of helium proved to be very close to 2·0, and, like argon, the ratio of its specific heat showed that it, too, was a monatomic gas. Its atomic weight, therefore, is identical with its molecular weight, viz., 4·0, and its place in the periodic table is between hydrogen and lithium, the atomic weight of which is 7·0.

The difference between the atomic weights of helium and argon is thus 36, or $40 - 4$. Now there are several cases of such a difference.

* Delivered August 19th.

For instance, in the group, the first member of which is fluorine, we have—

Fluorine	19	
Chlorine	35·5	16·5
Manganese	55	19·5
In the oxygen group—		
Oxygen	16	
Sulphur	32	16
Chromium	52·3	20·3
In the nitrogen group—		
Nitrogen	14	
Phosphorus	31	17
Vanadium	51·4	20·4
And in the carbon group—		
Carbon	12	
Silicon	28·3	16·3
Titanium	48·1	19·8

These instances suffice to show that approximately the differences are 16 and 20 between consecutive members of the corresponding groups of elements. The total differences between the extreme members of the short series mentioned are—

Manganese—Fluorine	36
Chromium—Oxygen	36·3
Vanadium—Nitrogen	37·4
Titanium—Carbon	36·1

This is approximately the difference between the atomic weights of helium and argon, 36.

There should, therefore, be an undiscovered element between helium and argon, with an atomatic weight 16 units higher than that of helium, and 20 units lower than that of argon, namely 20. And if this unknown element, like helium and argon, should prove to consist of monatomic molecules, then its density should be half its atomic weight, 10. And pushing the analogy still farther, it is to be expected that this element should be as indifferent to union with other elements as the two allied elements.

My assistant, Mr. Morris Travers, has indefatigably aided me in a search for this unknown gas. There is a proverb about looking for a needle in a haystack; modern science, with the aid of suitable magnetic appliances, would, if the reward were sufficient, make short work of that proverbial needle. But here is a supposed unknown gas, endowed, no doubt, with negative properties, and the whole world to find it in. Still, the attempt had to be made.

We first directed our attention to the sources of helium—minerals. Almost every mineral which we could obtain was heated in a vacuum, and the gas which was evolved examined. The results are interesting. Most minerals give off gas when heated, and the gas contains, as a rule, a considerable amount of hydrogen, mixed with carbonic acid, questionable traces of nitrogen, and carbonic oxide. Many of the minerals, in addition, gave helium, which proved to be widely distributed, though only in minute proportion. One mineral—malacone—gave appreciable quantities of argon; and it is noteworthy that argon was not found except in it (and, curiously, in much larger amount than helium), and in a specimen of meteoric iron. Other specimens of meteoric iron were examined, but were found to contain mainly hydrogen, with no trace of either argon or helium. It is probable that the sources of meteorites might be traced in this manner, and that each could be relegated to its particular swarm.

Among the minerals examined was one to which our attention had been directed by Prof. Lockyer, named eliasite, from which he said that he had extracted a gas in which he had observed spectrum lines foreign to helium. He was kind enough to furnish us with a specimen of this mineral, which is exceedingly rare, but the sample which we tested contained nothing but undoubted helium.

During a trip to Iceland in 1895, I collected some gas from the boiling springs there; it consisted, for the most part, of air, but contained somewhat more argon than is usually dissolved when air is shaken with water. In the spring of 1896 Mr. Travers and I made a trip to the Pyrenees to collect gas from the mineral springs of Cauterets, to which our attention had been directed by Dr. Bouchard, who pointed out that these gases are rich in helium. We examined a number of samples from the various springs, and confirmed Dr. Bouchard's results, but there was no sign of any unknown lines in the spectrum of these gases. Our quest was in vain.

We must now turn to another aspect of the subject, Shortly after the discovery of helium, its spectrum was very carefully examined by Profs. Runge and Paschen, the renowned spectroscopists. The spectrum was photographed, special attention being paid to the invisible portions, termed the "ultra-violet" and "infra-red." The lines thus registered were found to have an harmonic relation to each other. They admitted of division into two sets, each complete in itself. Now, a similar process had been applied to the spectrum of lithium and to that of sodium, and the spectra of these elements gave only one series each. Hence, Profs. Runge and Paschen concluded that the gas, to which the provisional name of helium had been given, was in reality a mixture of two gases, closely resembling each other in properties. As we know no other elements with atomic weights between those of hydrogen and lithium, there is no chemical evidence either for or against this supposition. Prof. Runge supposed that he had obtained evidence of the separation of these imagined elements from each other by means of diffusion; but Mr. Travers and I pointed out that the same alteration of spectrum, which was apparently produced by diffusion, could also be caused by altering the pressure of the gas in the vacuum tube; and shortly after Prof. Runge acknowledged his mistake.

These considerations, however, made it desirable to subject helium to systematic diffusion, in the same way as argon had been tried. The experiments were carried out in the summer of 1896 by Dr. Collie and myself. The result was encouraging. It was found possible to separate helium into two portions of different rates of diffusion, and consequently of different density, by this means. The limits of separation, however, were not very great. On the one hand, we obtained gas of a density close on 2·0; and on the other, a sample of density 2·4 or thereabouts. The difficulty was increased by the curious behaviour, which we have often had occasion to confirm, that helium possesses a rate of diffusion too rapid for its density. Thus, the density of the lightest portion of the diffused gas, calculated from its rate of diffusion, was 1·874; but this corresponds to a real density of about 2·0. After our paper, giving an account of these experiments, had been published, a German investigator, Herr A. Hagenbach, repeated our work and confirmed our results.

The two samples of gas of different density differ also in other properties. Different transparent substances differ in the rate at which they allow light to pass through them. Thus, light travels through water at a much slower rate than through air, and at a slower rate through air than through hydrogen. Now, Lord Rayleigh found that helium offers less opposition to the passage of light than any other substance does, and the heavier of the two portions into which helium had been split offered more opposition than the lighter portion. And the retardation of the light, unlike what has usually been observed, was nearly proportional to the densities of the samples. The spectrum of these two samples did not differ in the minutest particular; therefore it did not appear quite out of the question to hazard the speculation that the process of diffusion was instrumental, not necessarily in separating two kinds of gas from each other, but actually in removing light molecules of the same kind from heavy molecules. This idea is not new. It had been advanced by Prof. Schützenberger (whose recent death all chemists have to deplore), and later, by Mr. Crookes, that what we term the atomic weight of an element is a mean; that when we say that the atomic weight of oxygen is 16, we merely state that the average atomic weight is 16; and it is not inconceivable that a certain number of molecules have a weight somewhat higher than 32, while a certain number have a lower weight.

We therefore thought it necessary to test this question by direct experiment with some known gas; and we chose nitrogen, as a good material with which to test the point. A much larger and more convenient apparatus for diffusing gases was built by Mr. Travers and myself, and a set of systematic diffusions of nitrogen was carried out. After 30 rounds, corresponding to 180 diffusions, the density of the nitrogen was unaltered, and that of the portion which should have diffused most slowly, had there been any difference in rate, was identical with that of the most quickly diffusing portion—*i.e.*, with that of the portion which passed first through the porous plug. This attempt, therefore, was unsuccessful; but it was worth carrying out, for it is now certain that it is not possible to separate a gas of undoubted chemical utility into portions of different density by diffusion. And these experiments rendered it exceedingly improbable that the difference in density of the two fractions of helium was due to separation of light molecules of helium from heavy molecules.

The apparatus used for diffusion had a capacity of about two litres. It was filled with helium, and the operation of diffusion was carried through 30 times. There were six reservoirs, each full of gas, and each was separated into two by diffusion. To the heavier portion of one lot the lighter portion of the next was added, and in this manner all six reservoirs were successively passed through the diffusion apparatus. This process was carried out 30 times, each of the six reservoirs having had its gas diffused each time, thus involving 180 diffusions. After this process the density of the more quickly diffusing gas was reduced to 2·02, while that of the less quickly diffusing had increased to 2·27. The light portion on re-diffusion hardly altered in density, while the heavier portion, when divided into three portions by diffusion, showed a considerable difference in density between the first third and the last third. A similar set of operations was carried out with a fresh quantity of helium, in order to accumulate enough gas to obtain a sufficient quantity for a second series of diffusions. The more quickly diffusing portions of both gases were mixed and re-diffused. The density of the lightest portion of these gases was 1·98; and after other 15 diffusions, the density of the lightest portion had not decreased. The end had been reached; it was not possible to obtain a lighter portion by diffusion. The density of the main body of this gas is therefore 1·98; and its refractivity, air being taken as unity, is 0·1245. The spectrum of this portion does not differ in any respect from the usual spectrum of helium.

As re-diffusion does not alter the density or the refractivity of this gas, it is right to suppose that either one definite element has now been isolated; or that if there are more elements than one present, they possess the same, or very nearly the same, density and refractivity. There may be a group of elements, say three, like iron, cobalt, and nickel; but there is no proof that this idea is correct, and the simplicity of the spectrum would be an argument against such a supposition. This substance, forming by far the larger part of the whole amount of the gas, must, in the present state of our knowledge, be regarded as pure helium.

On the other hand, the heavier residue is easily altered in density by re-diffusion, and this would imply that it consists of a small quantity of a heavy gas mixed with a large quantity of the light gas. Repeated re-diffusion convinced us that there was only a very small amount of the heavy gas present in the mixture. The portion which contained the largest amount of heavy gas was found to have the density 2·275, and its refractive index was found to be 0·1333. On re-diffusing this portion of gas until only a trace sufficient to fill a Plücker's tube was left, and then examining the spectrum, no unknown lines could be detected, but, on interposing a jar and spark gap, the well known blue lines of argon became visible; and even without the jar the red lines of argon, and the two green groups were distinctly visible. The amount of argon present, calculated

from the density, was 1·64 per cent., and from the refractivity 1·14 per cent. The conclusion had therefore to be drawn that the heavy constituent of helium, as it comes off the minerals containing it, is nothing new, but, so far as can be made out, merely a small amount of argon.

If, then, there is a new gas in what is generally termed helium, it is mixed with argon, and it must be present in extremely minute traces. As neither helium nor argon has been induced to form compounds, there does not appear to be any method, other than diffusion, for isolating such a gas, if it exists, and that method has failed in our hands to give any evidence of the existence of such a gas. It by no means follows that the gas does not exist; the only conclusion to be drawn is that we have not yet stumbled on the material which contains it. In fact, the haystack is too large and the needle too inconspicuous. Reference to the periodic table will show that between the elements aluminium and indium there occurs gallium, a substance occurring only in the minutest amount on the earth's surface; and following silicon, and preceding tin, appears the element germanium, a body which has as yet been recognised only in one of the rarest of minerals, argyrodite. Now, the amount of helium in fergusonite, one of the minerals which yields it in reasonable quantity, is only 33 parts by weight in 100,000 of the mineral: and it is not improbable that some other mineral may contain the new gas in even more minute proportion. If, however, it is accompanied in its still undiscovered source by argon and helium, it will be a work of extreme difficulty to effect a separation from these gases.

In these remarks it has been assumed that the new gas will resemble argon and helium in being indifferent to the action of reagents, and in not forming compounds. This supposition is worth examining. In considering it, the analogy with other elements is all that we have to guide us.

We have already paid some attention to several triads of elements. We have seen that the differences in atomic weights between the elements fluorine and manganese, oxygen and chromium, nitrogen and vanadium, carbon and titanium, is in each case approximately the same as that between helium and argon, viz., 36. If elements further back in the periodic table be examined, it is to be noticed that the differences grow less the smaller the atomic weights. Thus, between boron and scandium, the difference is 33; between beryllium (glucinum) and calcium, 31; and between lithium and potassium, 32. At the same time, we may remark that the elements grow liker each other the lower the atomic weights. Now, helium and argon are very like each other in physical properties. It may be fairly concluded, I think, that in so far they justify their position. Moreover, the pair of elements which show the smallest difference between their atomic weights is beryllium and calcium; there is a somewhat greater difference between lithium and potassium. And it is in accordance with this fragment of regularity that helium and argon show a greater difference. Then, again, sodium, the middle element of the lithium triad, is very similar in properties both to lithium and potassium; and we might, therefore, expect that the unknown element of the helium series should closely resemble both helium and argon.

Leaving now the consideration of the new element, let us turn our attention to the more general question of the atomic weight of argon, and its anomalous position in the periodic scheme of the elements. The apparent difficulty is this:—The atomic weight of argon is 40; it has no power to form compounds, and thus possesses no valency; it must follow chlorine in the periodic table, and precede potassium; but its atomic weight is greater than that of potassium, whereas it is generally contended that the elements should follow each other in the order of their atomic weights. If this contention is correct, argon should have an atomic weight smaller than 40.

Let us examine this contention. Taking the first row of elements we have:

Li = 7, Be = 9·8, B = 11, C = 12, N = 14, O = 16, F = 19, ? = 20.

The differences are:

2·8, 1·2, 1·0, 2·0, 2·0, 3·0, 1·0.

It is obvious that they are irregular. The next row shows similar irregularities. Thus:

(? = 20), Na = 23, Mg = 24·3, Al = 27, Si = 28, P = 31, S = 32, Cl = 35·5, A = 40.

And the differences:

3·0, 1·3, 2·7, 1·0, 3·0, 1·0, 3·5, 4·5.

The same irregularity might be illustrated by a consideration of each succeeding row. Between argon and the next in order, potassium, there is a difference of − 0·9; that is to say, argon has a higher atomic weight than potassium by 0·9 unit; whereas it might be expected to have a lower one, seeing that potassium follows argon in the table. Farther on in the table there is a similar discrepancy. The row is as follows:—

Ag = 108, Cd = 112, In = 114, Sn = 119, Sb = 120·5, Te = 127·7, I = 127.

The differences are:

4·0, 2·0, 5·0, 1·5., 7·2, —0·7.

Here, again, there is a negative difference between tellurium and iodine. And this apparent discrepancy has led to many and careful redeterminations of the atomic weight of tellurium. Prof. Brauner, indeed, has submitted tellurium to methodical fractionation, with no positive results. All the recent determinations of its atomic weight give practically the same number, 127·7.

Again, there have been almost innumerable attempts to reduce the differences between the atomic weights to regularity, by contriving some formula which will express the numbers which represent the atomic weights, with all their irregularities. Needless to say, such attempts have in no case been successful. Apparent success is always attained at the expense of accuracy, and the numbers reproduced are not those accepted as the true atomic weights. Such attempts, in my opinion, are futile. Still, the human mind does not rest contented in merely chronicling such an irregularity; it strives to understand why such an irregularity should exist. And, in connection with this, there are two matters which call for our consideration. These are: Does some circumstance modify these "combining proportions" which we term "atomic weights"? And is there any reason to suppose that we can modify them at our will? Are they true "constants of Nature," unchangeable, and once for all determined? Or are they constant merely so long as other circumstances, a change in which would modify them, remain unchanged?

In order to understand the real scope of such questions, it is necessary to consider the relation of the "atomic weights" to other magnitudes, and especially to the important quantity termed "energy."

It is known that energy manifests itself under different forms, and that one form of energy is quantitatively convertible into another form, without loss. It is also known that each form of energy is expressible as the product of two factors, one of which has been termed the "intensity factor," and the other the "capacity factor." Prof. Ostwald, in the last edition of his "Allgemeine Chemie," classified some of these forms of energy as follows:—

Kinetic energy	is the product of	mass	into the square of velocity.
Linear	"	"	length into force.
Surface	"	"	surface into surface tension.
Volume	"	"	volume into pressure.
Heat	"	"	heat capacity (entropy) into temperature.
Electrical	"	"	electric capacity into potential.
Chemical	"	"	"atomic weight" into affinity.

In each statement of factors, the "capacity factor" is placed first, and the "intensity factor" second.

In considering the "capacity factors," it is noticeable that they may be divided into two classes. The two first kinds of energy, kinetic and linear, are *independent of the nature of the material* which is subject to the energy. A mass of lead offers as much resistance to a given force, or, in other words, possesses as great inertia as an equal mass of hydrogen. A mass of iridium, the densest solid, counterbalances an equal mass of lithium, the lightest known solid. On the other hand, surface energy deals with molecules, and not with masses. So does volume energy. The volume energy of 2 grammes of hydrogen, contained in a vessel of 1 litre capacity, is equal to that of 32 grammes of oxygen at the same temperature, and contained in a vessel of equal size. Equal masses of tin and lead have not equal capacity for heat; but 119 grammes of tin has the same capacity as 207 grammes of lead, that is, equal atomic masses have the some heat capacity. The quantity of electricity conveyed through an electrolyte under equal difference of potential is proportional, not to the mass of the dissolved body, but to its equivalent, that is, to some simple fraction of its atomic weight. And the capacity factor of chemical energy is the atomatic weight of the substance subjected to the energy. We see, therefore, that while mass or inertia are important adjuncts of kinetic and linear energies, all other kinds of energies are connected with atomic weights, either directly or indirectly.

Such considerations draw attention to the fact that quantity of matter (assuming that there exists such a carrier of properties as we term "matter") need not necessarily be measured by its inertia, or by gravitational attraction. In fact, the word "mass" has two totally distinct significations. Because we adopt the convention to measure quantity of matter by its mass, the word "mass" has come to denote "quantity of matter." But it is open to anyone to measure a quantity of matter by any other of its energy factors. I may, if I choose, state that those quantities of matter which possess equal capacities for heat are equal; or that "equal numbers of atoms" represent equal quantities of matter. Indeed, we regard the value of material as due rather than what it can do, than to its mass; and we buy food, in the main, on an atomic, or perhaps, a molecular basis, according to its content of albumen. And most articles depend for their value on the amount of food required by the producer or the manufacturer.

The various forms of energy may therefore be classified as those which can be referred to an "atomic" factor, and those which possess a "mass" factor. The former are in the majority. And the periodic law is the bridge between them; as yet, an imperfect connection. For the atomatic factors, arranged in the order of their masses, display only a partial regularity. It is undoubtedly one of the main problems of physics and chemistry to solve this mystery. What the solution will be is beyond my power of prophecy; whether it is to be found in the influence of some circumstance on the atomic weights, hitherto regarded as among the most certain "constants of Nature"; or whether it will turn out that mass and gravitational attraction are influenced by temperature, or by electrical charge, I cannot tell. But that some means will ultimately be found of reconciling these apparent discrepancies, I firmly believe. Such a reconciliation is necessary, whatever view be taken of the nature of the universe and of its mode of action; whatever units we may choose to regard as fundamental among those among those which lie at our disposal.

In this address I have endeavoured to fulfil my promise to combine a little history, a little actuality, and a little prophecy. The history belongs to the Old World; I have endeavoured to share passing events with the New; and I will ask you to join with me in the hope that much of the prophecy may meet with its fulfilment on this side of the Ocean.

ADDRESS TO THE MECHANICAL SCIENCE SECTION.

By G. F. Deacon, M.Inst.C.E., President of the Section.*

In this ever-memorable year of the Victorian Age, it is not unnatural that anyone called to fill the chair I occupy to-day should experience a sense of oppression, when contemplating the fruits of mechanical science during the last 60 years, and the tremendous vista, fading in the distance to a dream, of the fruits it is destined to produce before such another period shall have passed away.

There would be no possibility, in the time at my disposal, even if I were qualified to attempt it, of adequately reviewing the past; and however fascinating the thought may be, it would ill become my office to venture far along the vista before us, lest a too airy imagination should break the bonds of that knowledge and that truth to which she must ever remain, in our rightful speculations, a helpful, if not always an obedient, handmaiden.

In the year 1831, two places, the one ancient and memorable, the other young, but destined to become memorable, bore the name of York. At the first of these, amid relics of ancient Rome and lasting memorials of the better phases of Britain's mediæval history, were met together in that year the earliest members of the British Association. And as the sun at noonday shone on that ancient York, it rose upon the other York—a little town, scarcely more than a village of 1,700 people, fast springing from a plain on the shores of Ontario, where the wigwam of the Chippewa had lately been; and between the two lay the Atlantic and a distance of 4,000 miles.

Sixty-six years later, the British Association meets in that other York, distinguished under the name of Toronto, and grown into a noble city. Painfully, in stage coaches, must many of the founders of this Association have travelled to that ancient York; peacefully and amid all comfort and luxury have we from the mother country reached, at her invitation, this great city—chiefest, in its people, its commerce, and its University, of the cities of Western Canada.

Neither at the meeting in York of 1831, nor elsewhere, until many years later, was there any expectation of the possibility of these things. Six years later, about the beginning of that glorious reign of which the sixty-first year is now passing—although two or three vessels had already crossed the Atlantic under steam, it was still seriously doubted whether, without the aid of a Government subsidy of considerable amount, a line of steamers, even for the New York service, could be permanently maintained. It was not, indeed, until 1838 that the *Great Western* inaugurated the attempt on a commercial basis, and she performed in 15 days the voyage which is now regularly performed with complete commercial success in five.

Would not the suggestion of such a change, of such a spanning of great distances, of such a consequent growth of prosperity and of culture, within the reign of a princess then approaching womanhood, have been received as the wildest of forecasts by the British Association of 1831?

Yet this is but one of a multitude of results, no less startling, which the same agencies have brought about. We are now holding the second meeting of the Association in Canada, and at the first such meeting, held 13 years ago in Montreal, some hundreds of miles nearer home, Sir Frederick Bramwell told you from this chair, in his own inimitable way, the causes of so great a change, and he pointed out to you, as I venture to point out again, that the visible instruments of that change have been forged by the men who are, or were, or ought to be, the members of Section G. To such encouragement as Section G has given is largely due the progress and triumph of applied mechanics as the natural outcome of theoretical investigation and physical research. Finally, and with no reserve in the minds of reasonable men, the old fallacy of a discord between theory and practice has been swept away. For centuries that fallacy held apart, as it were, the oxygen and the nitrogen of that atmosphere in which alone the new life could exist. It limited the philosopher who examined the laws of nature almost entirely to the study of phenomena external to the earth on which he dwelt, and it stamped the practical man as a lower being, the possessor of certain necessary knowledge, having no relation to the studies of the schoolmen, and which it would be beneath their dignity to pursue. And notwithstanding the great names which have stood out in opposition to these views, the popular idea of discord between theory and practice took long to die, and only within the Victorian Age has the complete truth been generally recognised, that if one fails to account for the result of any physical combination, the cause is to be found not in any discord with theory, but in the fact that the observer has failed to discover the whole of the theory.

We English-speaking people, alone, I believe, among civilised nations, use this word, *theory*, with unpardonable looseness—as almost synonymous in effect with *hypothesis*, and the result is fruitful of error. Until the truth of any hypothesis is placed beyond all manner of doubt it is not, and should never be called, the theory.

Within these walls, the *genius loci* impels me to thoughts which have not often entered into discussions of Section G; and, perhaps, if this address were to be discussed I should choose subjects and premises, the proof of which, to the satisfaction of others than myself, it would probably be less difficult to maintain. In this University of Toronto under whose *ægis* all that was best in the older schools of thought is cultivated by the side of those practical applications of science which in bygone days were distinguished as the unworthy uses of philosophy, one's thoughts insensibly turn to the marvellous change in the opportunities afforded for acquiring a knowledge of applied science—for becoming, in short, an engineer.

It is not proposed to discuss the progress and prosperity which mechanical science has brought about in the Victorian Era, much less that which the succeeding years will yield; but I venture to think that a proper subject for consideration from this chair, if not for discussion in this section, is to be found in any unnecessary waste of energy which may occur in the process of mental development of the men who are to succeed us in the great work to which we devote our lives. Obviously, it is to the interests of our calling, and consequently of the nation at large, that such waste should be reduced to a minimum, and therefore I make no apology for mentioning certain points in which its presence is particularly striking. There may be waste of potential, as well as of actual energy, and if we fail to expend energy on certain subjects because our time is occupied with others which are less useful, it is waste of energy only differing in degree from its expenditure on useless subjects. There is assuredly no lack of potential energy in the coming race. In spite of any training, whether well or ill directed, a large proportion will become actual and useful energy; but guidance and direction being given, the mode of that guidance and direction should be the one best calculated to secure the highest possible proportion of useful effect.

If we look back at the greatest names among the engineers and inventors of the latter part of the eighteenth century and the first half of this, we find that the majority were brought up in pursuits quite distinct from the work of their after lives, and by which they have become so familiar to us. There were scarcely any means whatever, beyond the original thought and dogged perseverance of the worker, by which those men could atttain the knowledge they used with such effect. Men of no less exceptional parts are among us now, but the whole environment of their early work has changed. We have given to the exceptional man a starting point of knowledge which, wisely used, lifts him as high above our heads as of old, but we have given to the average man a comparative easy means of attaining the same knowledge. We cannot ensure the wise use of that knowledge, but we can at least endeavour to impart it in such a manner that the sense of right proportion shall be acquired and maintained. We have made it more difficult to distinguish between the exceptional and the commonplace—between the gold and the silver, if not between the silver and the brass; let us be careful, so far as early guidance can control it, that the knowledge imparted to the average mind gives to that mind a fair start concerning the relations, undivided and indivisible, between true theory and sound practice.

Having myself passed as an ordinary apprentice through workshops of mechanical engineering in the old days when working hours were longer than they now are—from six in the morning till six in the evening, and that, too, on the banks of the Clyde, where no special indulgence was given to what was sometimes called the "gentleman apprentice," and feeling convinced, as I still do, of the immense and permanent advantage derived from that experience, I shall not be judged to underrate its value in the case of others who have yet to choose the details of the career by which they expect to gain a place in the profession or business of an engineer.

On the other had, as a student thirty-four years ago under the late Professor Macquorn Rankine and the present Lord Kelvin, I shall not be prone to under-estimate the advantages of academical training in its proper application to the profession to which I am proud to belong.

In the pursuit of that profession it has fallen to my lot to observe the training as engineers of many younger men—men of variously constituted minds, but one and all bent on learning some portion of "the art of directing the great sources of power in nature for the use and convenience of man," words wisely chosen, 69 years ago, and set out as the object of the profession in the Royal Charter of the Institution of Civil Engineers. It is a noble object, this *direction of the great forces of nature for the use and convenience of man*; it is an ambitious object, and one which I venture to think demands for its right performance the best energies of well-balanced minds working upon a store of knowledge which nothing but years of untiring study and observation can give. Yet there is no hesitation shown to enter the lists. The number of candidates is appalling. In the old country, at least, there certainly is not work for all, but when one points this out, anxious parents only reply that the difficulty is as great in connection with any other profession. Whether this be so or not I cannot judge, but I am persuaded that of those who do enter the business or profession of the engineer, the enormous majority are not born engineers, and cannot, in the nature of things, hope for success unless they take advantage of the best facilities open to them—the *best facilities*; here is the difficulty: from the multitude of facilities how are we to choose?

Do not suppose that I think the training of the born engineer should not be controlled. He will stand head and shoulders above the rest of us whatever we may do with him; but in order that his exceptional parts may not wreck him as an engineer, and in order that his energies may be rightly directed at the start, he, too, should have the advantages of that systematic training which to his less gifted brethren is becoming more and more absolutely essential to success.

At the time I began practice the large majority of young engineers were left entirely to their own devices so far as the attainment of any scientific knowledge was concerned. As pupils or apprentices, articled or not, they entered an engineer's works or office; for a certain number of years they had the run of the place and some encouragement if they worked well, but it could not, in the nature of things, amount to much more. This was a very necessary, perhaps the most necessary, element of their training; but except to the few who were so constituted that with little or no guidance they could supplement their practical knowledge with the study of principles elsewhere, it was entirely ineffectual in the production of that well-balanced attitude of mind which any person who properly assumes the name of an engineer must hold towards every engineering problem, great or small, which he is called upon to solve. And so strongly have I felt this, that in the earlier days, when there were fewer schools of practical science, and when their utility was little understood, I required, wherever the matter was under my control, the insertion into the articles of apprenticeship of a clause by which,

* Delivered August 19th.

at some inconvenience to the office, the pupil was required to attend two sessions at the science classes of Glasgow University, or at some other approved school of practical science; and without this condition I declined to take the responsibility attaching to the introduction into the profession of men who, in their earlier careers, from no fault of their own, had not even acquired a knowledge of what there was to learn, much less of how to learn it.

More recently this course has generally become unnecessary; for in Westminster, at least, the young engineer rarely enters an office until he has acquired some knowledge of what he has to learn. He enters, in short, at a much more advanced age than formerly. When it is essential that he should be earning something soon after he comes of age, anything like a complete training is an impossibility; his work ceases to be general, and his practice is more or less confined in a much narrower sphere than need be the case if the pursuit of further knowledge continues to be his chief duty.

But whatever course his circumstances may permit him to adopt, the difficulty of gaining the required knowledge in the time available is a serious one. This is not the place to inquire whether public school education in the mother country, is, or is not, the best for the general purposes of after life, or to discuss what improvements may be made in it; and of higher education in Canada I unfortunately know little or nothing. Personally I admit the possibility of improvement in the English system, and slowly but surely improvement is creeping in, as such changes rightly find their way into institutions which have done so much for Englishmen. In this particular I lean to the conservative side, and whatever our individual views may be concerning the time spent on the study of Latin and Greek, we should all probably agree that the school education of an engineer should be as thorough and liberal as for any other profession. But for the sake of a technical training to follow, this school education is often unduly curtailed, to the great after-grief, in very many cases, of the successful engineer, and not infrequently also of the less successful engineer who, in some phases of his professional career, has been only too keenly alive to the self-reproach and sense of inferiority which want of thoroughness or of time, or of both, at school has brought upon him.

But at some time the boy must leave school. Let us hope that he does not aspire "to control the great forces of nature"; but if he does we must make the best we can of him.

It is not desirable, at least so it appears to me, that even at this stage his training should be specialised in view of the particular branch of the profession or business he is likely to follow. The fundamental principles of any branch of mechanical engineering are broadly the fundamental principles of any branch of the profession. I hesitate to speak of civil engineering as if it were a separate branch, instead of being, as it really is, the generic name of the profession; but the training demanded for the various branches of civil engineering in its narrower sense is precisely the same as that required in its earlier stages for mechanical engineering pure and simple.

I shall make no attempt to review the large number of excellent courses which are now available for the teaching of applied science in relation to engineering. Experience of the results as judged by the students who have come directly under my notice, and examination of many calendars, has aroused various thoughts concerning them, and this thought is perhaps uppermost: *are we not in some cases attempting at too early a stage the teaching of subjects instead of principles?* Complete subjects, I mean, including the practical working of details which will become the regular study of the student in the office or works of an engineer. It certainly seems to me to be so. I do not say that subject training of this kind at college may not be useful; but we have to consider whether it does not, for the sake of some little anticipation of his office work, divert the attention of the student from the better mastery of those principles which it is so essential for him to grasp at the earliest possible time, and which do not limit his choice in the battle of life to any branch whatever of the profession or business of an engineer, but which, on the contrary, qualify him better to pursue with success whatever branches his inclination or his opportunities or his means may suggest. Not one in a hundred of us can hope to emulate the careers of exceptional men in our profession, but it is sometimes useful to observe those careers, and whenever we do so we find the very reverse of specialisation. The minds of such men are impregnated with the fundamental principles which we may call the common law of our art; it has happened that their practice has been large in certain branches, and small or wanting in certain others; but in any it would have been equally successful. Of no class of men can it be said of greater truth than of engineers that their standard should be sound knowledge of the principles of many things and of the practice of a few.

There is some danger in the usual limitation of compulsory subjects in examinations for certificates and degrees. When an examination has to be passed subjects not made compulsory are too often entirely neglected, however important to the engineer they may be. A little learning is certainly not a dangerous thing if within its limits it is sound, and every engineer will in after life be grateful to those who in his student days insisted upon his acquiring some knowledge of the principles of such subjects as electricity and chemistry. At present it too often happens that, unless an engineering student is predestined to practise electrical work or some chemical industry, he begins life as an engineer with no knowledge of the principles of either the one or the other, and chiefly as a result of their neglect for the sake of certain subjects made compulsory for the test he has had to pass, which subjects too occasionally include the highly specialised favourites of a particular professor or verge too completely on perfected details which, I venture to think, cannot be rightly mastered in schools. It is natural and right that each professor of a principal subject should seek to make the best, from his own particular standpoint, of every student who attends his lectures or his laboratories; and the professor of a compulsory subject cannot be expected to encourage the inclusion, in a course already overcrowded, of secondary or collateral subjects which are dealt with by other professors; while, on the other hand, the professors of secondary subjects, such as electricity or chemistry, not unnaturally value chiefly the students who make those subjects their principal work.

For these reasons it appears to me that a certain very moderate standard in all such subjects should be made compulsory if a certificate of proficiency, whether by degree or otherwise, is to be given in engineering or even in physical science.

In the teaching of mathematics within the Victorian age a considerable change has taken place, and I plead for still a little more change in the same direction where the training of the engineer is concerned. Mathematics, as taught in our public schools—let us say for the Cambridge University Tripos—may be all that is claimed for it as a mode of mental culture; but of kindred mental culture the engineer must necessarily have more than most men, and much might therefore be omitted which, to him at least, has only an abstract value, to the great advantage of his mastery over those branches which at once train his mind and give point and direct utility to his solutions.

In America I understand that a college course of engineering generally includes workshop practice designed to supersede the old system of apprenticeship to a mechanical engineer. This fact and other important differences between the English and American practice having only lately come to my knowledge, and before they did so the substance of this address had been written. It might, in some particulars, require modification as applied to Canada, but it remains the result of my observations concerning the conditions of engineering education which obtain in the mother country.

A few words now in relation to that physical and mental training gained laboriously, and somewhat wastefully as I think, at the joiner's bench, in the fitting and turning shops, the foundry and the forge, during the whole course of mechanical engineering apprenticeship. I am convinced that the kind of knowledge which comes of thoughtful chipping and filing and turning and forging, though only applied to a few of the materials with which in after life the engineer has to deal, are quite as important as tables of density and strength to his future sense of rightness in constructive design. The use of such work is not merely to teach one the parts and combinations of any particular machine; in a still higher degree it is the insensible mastery of a much more subtle knowledge or mental power, the application of the senses of sight and touch and force, it may be of other senses also, to the determination of the nature of things. (I am not going to apologise for referring to the *sense of force*. The vexed question of its separate existence appears to me to have been settled 14 years ago by Lord Kelvin in his address at Birmingham on "the six gateways of knowledge," and I may well leave it where he left it.) I should altogether fail to describe adequately what this mastery means. It appears to me to be inscrutable. The value and nature of the power can only be appreciated by those who have experienced it, and who have felt its defect in those of their assistants or in others who do not possess it.

But the great workshop training has still further advantages. The apprentice is surrounded by skilled workers from whose example, if he is wise, he learns a great deal; and apart from this it is no small profit to have rubbed against the British workman, to have discovered what manner of man he is, and to comprehend how little the world knows of his best parts. The whole time spent in large engineering works, cannot, however, be equally beneficial; the apprentice must take the work as it comes; the most interesting or instructive portions cannot be reserved for him, and he often feels that some of his time is being well-nigh wasted.

A few years ago I should not have thought it practicable usefully to substitute for such a course anything that could be undertaken in a student's workshop, however organised; but the impossibility, in many cases, of including such experience without neglecting something equally important has led me to view with satisfaction the introduction of workshop training into certain schools of applied science in England. Such a change cannot of course carry with it all the advantages of experience in the great workshop and of contact with its workers, but those advantages which it does retain may be secured in a shorter time where there is no commercial interest to be served.

In Canada and the United States, as I have already said, the principle of the student's workshop has been carried considerably further. Compared with the old country, I believe the number of young assistant engineers who in proportion to the number of their chiefs can find employment in America is much greater, and that it would be practically impossible for the British system of pupilage to be generally employed. Here, therefore, the whole college training of an engineer is designed to fit him for immediate employment in some specific branch of the profession, and up to this point his training is, necessarily no doubt, more academic than in England, where the application of the principles he has acquired at college is still generally left for the office or works of the engineer. With this difference I am not at present concerned, but I desire to reiterate what I have already said to the effect that where, as in England, the student of engineering has the opportunity of continuing his training in the office or works, it is better that his limited college course should cover all that is possible of the principles of those sciences which may prove useful or necessary to him in after life, rather than that any of them should be omitted for the sake of anticipating the practical application of certain others.

The compulsory inclusion of the principles of all such subjects as chemistry, electricity, geology, and many others, in science courses intended for a future engineer is desirable, not only because a fundamental knowledge of them leaves open a very much wider field from which the engineer may, as opportunity offers, increase his knowledge and practice in the future, but because many of such subjects

are inseparable from an intelligent understanding of almost any great engineering work. "Nothing so difficult as a beginning," may be a proverb of rather too far-reaching a nature, but it contains the suggestion of a great truth, increasing in weight as we grow older, and the beginnings of such collateral sciences should therefore find a place in every engineering student's store of early knowledge.

But after all, when these things have been done in the best manner —when the scientific and practical training of the engineering student has been all that can be desired, it is a matter of general experience among engineers who have closely watched the rising generation that the most successful men in after life are not produced exclusively from the ranks of those whose college course has been most successful. No doubt such men have on the average been nearer the top than the bottom, but it is an undoubted fact that when we class them according to their earlier successes or failures we find the most remarkable disparities. We find many who in academic days gave but little promise, and we miss large numbers who promised great things. These facts are not confined to the profession of the engineer, but they seem to me to be accentuated in that profession. We shall no doubt be right in attributing the disparity to differences of mental temperament and of opportunity; but does it follow that there are no faculties which may be cultivated to reduce the effect of such differences? I venture to think there are. I will instance only one, but perhaps the most important of such faculties, and which in my experience among young engineers is exceptionally rare. I refer to the power of marshalling facts, and so thinking, or speaking, or writing of them that each maintains its due significance and value.

In the minds of many young engineers a mathematical training undoubtedly has the effect of making it extremely difficult to avoid spending an amount of time upon some issues out of all proportion to their importance; while other issues which do not readily lend themselves to mathematical treatment, but which are many times more important, are taken for granted upon utter insufficient data, and chiefly because they cannot be treated by any process of calculation. I believe that nothing but well-directed observation and long experience can enable one to assign to each part of a large engineering problem its due importance; but much may be done in early training also, and I think ought to be done, to lead the mind in broader lines, to accustom it to look all round the problem, and to control the imagination or the natural predilection for one phase from disguising the real importance of others. In the practical design and execution of important works the man will sooner or later be recognised who has the power so to formulate his knowledge, and on the same principles has succeeded in so marshalling and expressing his thoughts, as to convey to those by whom he is employed just so much as may be necessary and proper for their use.

Such considerations are not, it is true, a branch of mechanical science, but being essentially important to the attainment of maximum usefulness in the application of any science to the various branches of engineering which are the chief ends and aims of mechanical science, they are, I think, worthy of mention from this chair.

In proportion as the engineer possesses and exercises such powers he will avoid those innumerable pitfalls to which imperfectly instructed ingenuity is so particularly liable, and to which the Patent Office is so sad a witness; and in the same proportion must always be the useful outcome of the great schools of science which have become so striking a feature of the later Victorian age.

In relation to the results of applied science, I have spoken only of the steamship; add the telegraph, and I think we have the most important tools by which the present conditions of modern civilisation have been rendered possible. And more than this, I think we have, in the lessening of space, and the facility for intercourse they give, the chief secret of that marvellous development of the empire which this year has so pleasantly and so memorably signalised. Is "Our Lady of" the Sunshine and "the Snows" no nearer to the mother land than sixty years ago? Are the Australias—New Zealand—no nearer to both? Assuredly they are. Would British Africa, would the Indian Empire have been possible to Britain on the principles and the methods of Imperial Rome? Unquestionably not. Then let me say again that I claim for the objects and the work of Section G a magnificent record, an abiding power for the peace of the world, and for the unity and prosperity of the great empire to which we belong.

NEW PATENTS AND ABSTRACTS OF PUBLISHED SPECIFICATIONS.

NEW PATENTS.—1897.

[*Compiled expressly for this journal by* W. P. Thompson & Co., *Electrical Patent Agents, 322, High Holborn, London, W.C., to whom all inquiries should be addressed.*]

18,095. "Improvements in method of and means for operating alternating current motors." The British Thomson-Houston Co., Ltd. (C. P. Steinmetz, United States.) Dated August 3rd. (*Complete.*)

18,113. "Improvements in or relating to winding apparatus for field telephones, wires, or the like." L. Boije. Dated August 3rd.

18,118. "Improvements in plug switches for electric circuits." T. H. Marsh and A. Vandam. Dated August 3rd.

18,119. "Improvements in incandescence electric lamp holders." T. H. Marsh and A. Vandam. Dated August 3rd.

18,120. "Improvements in the manufacture and production of electric cables." H. Edmunds. Dated August 3rd.

18,122. "Improvements in transmitting sounds by telephony." J. W. Gibboney. Dated August 3rd. (*Complete.*)

18,173. "Instruments for measuring and recording the supply of electric current." W. A. Price. Dated August 4th.

18,176. "Improvements in or relating to electrical accumulators or storage batteries." A. Heil. Dated August 4th.

18,219. "Improvements in electric pendulum indicators, and also in electric bell pushes." D. F. Laing. Dated August 5th.

18,230. "Improvements in apparatus for electrically actuating and controlling ships' rudders or other mechanism." S. Pitt. (Societe Sautter Harlé and Compagnie, France.) Dated August 5th. (*Complete.*)

18,235. "Improvements in connection with arc lamps." W. J. H. Jones, F. J. Chaplin, and S. Jevons. Dated August 5th.

18,236. "Improvements in electric furnaces." T. Jackson. Dated August 5th.

18,272. "Improvements in the manufacture by electrolysis of sheets or objects of polished metal." L. E. Dessolle. Dated August 5th.

18,274. "Improvements in electrically operated hand tools." E. W. Jungner. Dated August 5th.

18,276. "Improvements in electric lamps for miners' use." H. H. Lake. (O. Siedentopf, Germany.) Dated August 5th. (*Complete.*)

18,278. "Improvements in and relating to brushes for electro-dynamo machines." G. C. Marks. (A. Bouvier, France.) Dated August 5th.

18,284. "A new and improved method of making high electrical resistances." F. B. Fawcett. Dated August 6th.

18,289. "Improvements connected with the ignition of gas lights by means of electric sparks." R. J. Urquhart. (The Actien Gesellschaft für Fabrikation von Broncewaaren und Zinkguss vorm, J. C. Spinn und Sohn and S. J. Von Romocki, Germany.) Dated August 6th.

18,290. "Improvements in apparatus for electrically controlling and igniting gas burners." R. J. Urquhart. (The Actien Gesellschaft für Fabrikation von Broncewaaren und Zinkguss vorm, J. C. Spinn und Sohn and S. J. Von Romocki, Germany.) Dated August 6th.

18,337. "Improvements in elec'rical cut-outs." H. Hirst. Dated August 6th.

18,354. "Improvements in apparatus for measuring and recording electric currents." H. Aron. Dated August 6th.

18,371. "Improvements in electric demand meters." A. Wright. Dated August 6th.

18,393. "Improvements in dynamo electric machines." H. Chitty. Dated August 7th.

18,398. "A device for controlling or dimming electric lights." N. Staniland and O. P. MacFarlane. Dated August 7th.

18,399. "Electric safety or protective device." N. Staniland and O. P. MacFarlane. Dated August 7th.

18,416. "Improvements in or relating to electric traction." S. P. Thompson and M. Walker. Dated August 7th.

18,430. "Improvements in the manufacture of electric accumulators. F. Pescetto. Dated August 7th. (*Complete.*)

ABSTRACTS OF PUBLISHED SPECIFICATIONS.

[*Copies of any of these Specifications may be obtained of* Messrs. W. P. Thompson & Co., 322, High Holborn, W.C., *price, post free,* 8½d. (*in stamps*).]

1896.

13,520. "Improvements in plates for accumulators or secondary batteries." Charles Pollak. Dated June 18th, 1896. An intimate connection is effected between the core and the porous layers so that the two parts really consist of one metallic piece. This state of affairs is brought about by casting simultaneously, and under pressure a solid core of any desired shape, and a porous portion in a suitable mould over a powdered body until the metal is solidifies. 2 claims.

13,896. "Improvements in machinery or apparatus for transmitting motion from electric motors to other machinery." W. W. Hulse. Dated January 20th, 1896. Relates to a method of transmitting motion from an electric motor to another machine. The apparatus consists of a countershaft driven from the driving shaft of the electric motor. A series of toothed wheels of different diameters fixed upon a shaft of the machine to be driven and an adjustable intermediate toothed wheel arranged to be driven from the countershaft and capable of being put in or out of gear with any one of the toothed wheels of different diameters. 2 claims.

26,069. "New or improved electric lighting or igniting apparatus." E. Oldenburg. Dated November 18th, 1896. Relates to an igniting device which consists of a galvanic battery provided with devices for holding the positive element normally out of contact with the electrolyte but enables it to be immersed therein when required, and a spirit lamp provided with a platinum igniting wire connected with the positive and negative elements of the galvanic battery. 4 claims.

28,488. "Improvements in or relating to electric arc lamps." T. Soencer and C. T. Toerring, Jr. Dated December 12th, 1896. Relates to a feed regulator for an electric arc lamp in which a carbon carrier is capable of removing between parallel guides, pivotally connected and continuously engaging the carrier on their facing edges only, and of being controlled by a feed-controlling magnet to cause the guides to approach or recede from one another under the fluctuations of the current due to changes in the arc, and in which the ends of the movable carbon near the arc is centered by a fixed guide. 3 claims.